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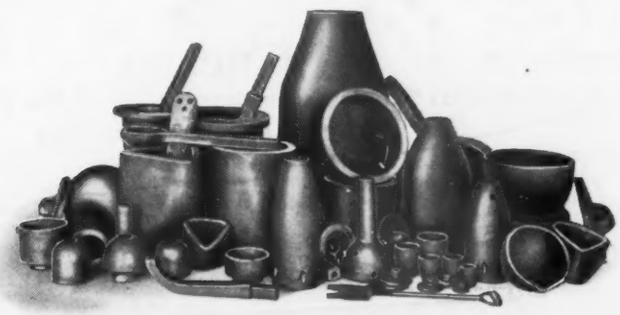

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THE FOUNDRY

Vol. 33, No. 4 CLEVELAND, OHIO, DECEMBER, 1908 Whole No. 196

PRODUCTION OF ALUMINUM CASTINGS

Manipulation of this wonderful white metal in the foundry---
Practice of the largest maker of aluminum castings in the world

THE production of aluminum castings, notwithstanding the low melting point of the metal, is beset with many difficulties not encountered in gray iron or steel foundry practice. The same general method is followed as in making brass castings, but the properties of the metal are unlike any of the bronzes. The high shrinkage, averaging 13/16 of an inch per foot for pure aluminum, and about 5/32 of an inch for the alloys most generally used, results in cracks and depressions unless great care is exercised in the preparation of the molds and the pouring of the metal. The tendency of aluminum to absorb gases when slightly overheated results in blow holes, which can be only overcome by pouring the metal as cold as possible.

The slightest variation in the metal thickness of the casting to be made is liable to cause the metal to draw, and chills are used freely in molds and cores to insure the rapid setting of the heavier parts. Great care must also be exercised in locating the gates, which should be large, and they should not be placed at points where there is any danger of drawing away from the castings. To provide for the excessive shrinkage, risers are used extensively, and it is not uncommon to place three or four on a casting weighing not over 50 pounds. The growth of the automo-

FIG. 1—SHAKING OUT A MOTOR CAR BODY CASTING

FIG. 2—MOLDING PART OF A MOTOR CAR BODY

FIG. 3—CHEEK, DRAG AND COPE OF A TONNEAU MOLD

FIG. 4—ALUMINUM MELTING FURNACES WITHOUT JACKETS IN THE DETROIT PLANT

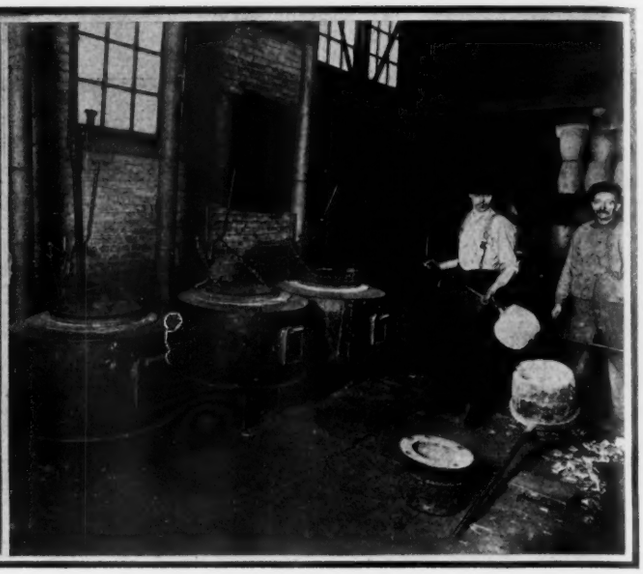


FIG. 5—A BATTERY OF ALUMINUM MELTING FURNACES IN THE CLEVELAND PLANT

bile industry in this country has fostered this branch of the foundry trade, and it can be safely stated that the bulk of aluminum consumed for casting purposes is used in the construction of motor cars. The extreme lightness of the metal and high tensile strength makes it desirable for crank and engine cases, while entire car bodies are being cast, and at a cost considerably below that of wood. It is an exceptionally large body that weighs more than 75 or 80 pounds and the metal thickness specified ranges from ⅛ to 5/32 of an inch. Some automobile makers, however, object to the use of aluminum for car bodies owing to the fact that it is easily dented and does not hold screws well, but these disadvantages have not limited its use, nor retarded the constantly growing demand.

Large Consumption of Aluminum.

The Allyne Brass Foundry Co., operating plants at Cleveland, Buffalo and Detroit, is probably the largest consumer of aluminum in the world, having melted about 2,000,000 pounds in 1907. Approximately 90 per cent of this product was made for the automobile trade, and to fill one order 500,000 pounds was required. This concern likewise engages in the manufacture of brass castings, the output of aluminum and bronze being about equally divided. When operating at full capacity, 250 men are employed in the Cleveland plant, 300 in Detroit, and 250 in Buffalo. The three foundries are especially equipped for aluminum work and the practice ranks favorably with that of other shops making a specialty of this line.

Aluminum Alloys.

One of the first problems that had to be solved by the Allyne company in endeavoring to make sound castings for the automobile trade involved a suitable alloy that would successfully withstand the severe vibration of motor car service. One of the first alloys tried contained two parts, by weight, of aluminum to one of zinc. This failed rapidly in service although it showed a tensile strength of 35,000 pounds per square inch of section, and specific gravity of 3.1, a little more than one-third

FIG. 6—FLOOR MOLDING DEPARTMENT OF THE BUFFALO PLANT

FIG. 7—ANOTHER VIEW OF THE BUFFALO FOUNDRY

FIG. 8—PIT MELTING FURNACE, CLEVELAND PLANT

FIG. 9—BRASS MELTING FURNACES, BUFFALO PLANT

the weight of a bronze casting from the same pattern. Another alloy tried, and which is still used to some extent by aluminum foundries, contains aluminum 83, zinc 15, and copper 2. This alloy has a tensile strength of about 23,000 pounds, but the presence of zinc has made it objectionable for automobile use, as it is claimed that this ingredient results in crystallization, and the casting frequently fractures as a result of the vibration, after being in use only a short time.

The alloy that is now being used exclusively by this concern contains aluminum 92, copper 8, (approximately) and a small percentage of nickel. Its tensile strength is about 21,000 pounds per square inch, specific gravity 2.85, and its melting point is 1,156 degrees Fahr. The shrinkage is approximately 5/32 of an inch per foot.

Melting Methods.

The appearance of blow holes underneath the surface of the castings resulted in the investigation of melting methods, and furnaces with cast iron pots are now used almost exclusively by the three plants. The pit furnace for aluminum work was not discarded on account of inefficiency, but the oil and gas furnaces melt at a greatly reduced cost and no crucibles are required. As both nitrogen and hydro-carbon gases are especially liable to be absorbed by molten aluminum, a furnace was designed which would carry off all of the products of combustion and effectively prevent them from coming in contact with the molten bath.

Furnaces.

In Fig. 5 are shown three furnaces in the Cleveland plant, and a battery without jackets installed in the Detroit foundry is shown in Fig. 4. The pots are made of gray iron flanged at the top where they rest on the furnace body. Outlets for the products of combustion are provided by steel tube nipples tapped into the furnace body close to the top, as shown in Fig. 4, taking elbows pointing downward. Vent pipes leading outside of the building are connected with the outer shell, as shown in Fig. 5, which carry off the gases. The top of the pot is covered by a horizontal fire brick lid, closely fitted

FIG. 10—BENCH MOLDING FLOOR, CLEVELAND PLANT

FIG. 11—A VIEW OF THE DETROIT PLANT

FIG. 12—A CORNER OF THE FLOOR MOLDING DEPARTMENT, BUFFALO PLANT.

FIG. 13—POURING AN ALUMINUM CASTING IN THE BUFFALO FOUNDRY

to protect the metal from the air and other oxidizing influences. The furnaces are fired by both natural and illuminating gas, mixed with air at a pressure of one pound. The metal is melted continuously, each pot having a capacity of about 250 pounds. Owing to the high temperature to which the pots are subjected they must be replaced about every two weeks, and the slightest defect in the gray iron casting frequently results in a break-out after a few heats.

Crucible Furnaces.

A section of a battery of 20 pit melting furnaces used almost exclusively for brass in the Cleveland plant, is shown in Fig. 8. When an exceptionally large heat of aluminum is required some of the metal is melted in the crucibles, but this practice is not generally followed. The crucibles that are to be used for aluminum are given an initial heat of bronze, as the white metal has a tendency to soften the new pot. Crucibles used for aluminum exclusively are usually assured a long life, owing to the low temperature to which they are subjected, and frequently records of 100 heats have been made.

Pot Lifting Device.

The pot lifting device shown in Fig. 8 has proven very satisfactory, three being used for the entire battery of furnaces. They operate on an overhead I-beam and the head of the lifter is a quadrant fitted with a chain and block which engages the tongs. The method of seasoning crucibles is also shown. When new pots are received they are placed on the upper shelf until they have been thoroughly dried, and being stored directly over the furnaces are always at a moderate temperature and in condition for use. The brass melting furnaces in the Buffalo plant are shown in Fig. 9.

Casting Aluminum.

Aluminum is poured into molds from crucibles which have been previously preheated to about the temperature of the metal, which is tapped out of the pots with a cast iron ladle as shown in Figs. 4 and 5. The metal is well stirred and the dross

FIG. 14—CLEANING DEPARTMENT, DETROIT PLANT

FIG. 15—CORE OVENS, BUFFALO PLANT

FIG. 16—SAND-BLASTING ALUMINUM CASTINGS AT THE CLEVELAND PLANT

FIG. 17—SOME OF THE INTRICATE CORES FOR AUTOMOBILE WORK

scraped off with a long-handled steel scraper, and a handful of coarsely powdered sal-ammoniac is thrown into the crucible to purify the metal. As the temperature of the metal from its appearance is somewhat deceiving, a bar of aluminum is stirred in the crucible and melted just before casting. The rapidity with which the bar melts is the best indication of the proper casting temperature.

The method of pouring a mold is shown in Fig. 13. The casting is very light, yet two crucibles are used, and the metal is forced into the molds as rapidly as it will flow. For pouring exceedingly fine castings, the metal is used at a temperature lower than for castings of a greater metal thickness. Rapid pouring is necessary owing to the fact that the metal sets very quickly and owing to its high shrinkage.

Scrap.

The percentage of scrap, owing to the heavy gates and risers used, is very large in proportion to the weight of the product, and this is remelted with an addition of new aluminum. The dross is likewise remelted and cast into small ingots, but the amount of metal recovered in this way is very small, and the skimmings are subsequently sold to the producers of aluminum alloys. To keep the metal as free from dirt as possible the gates, sprues, and risers are sand-blasted, and one of these departments in the Cleveland plant is shown in Fig. 16. Practically all of the castings are cleaned in this way, which gives them a frosted appearance, and in addition reveals blow holes and other defects underneath the surface, which could not otherwise be detected until after the castings have been machined.

Use of Chills.

Chills are used extensively in the molds for aluminum castings. A Stearns motor car crank case, shown in Fig. 18, owing to the great variations in the metal thickness requires 16 in the drag, seven in the cope, and in the cores shown in Fig. 22, which are set in this mold, no less than 68 are placed. The cope and drag patterns for this casting are shown in

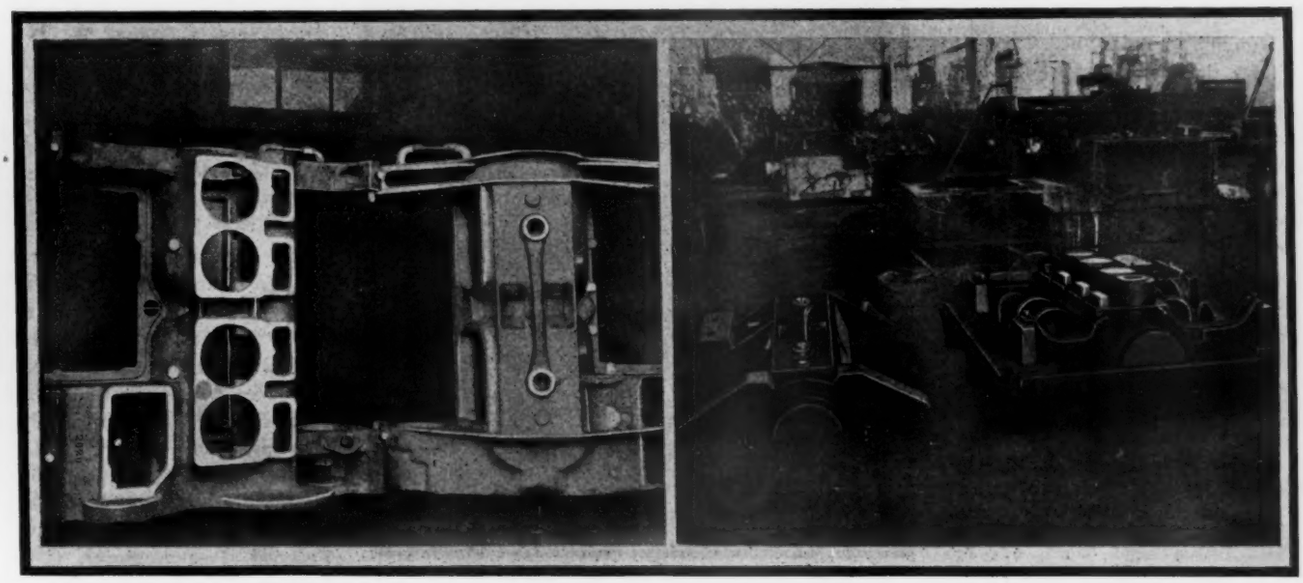


FIG. 18—FRONT AND REAR VIEWS OF A STEARNS CRANK CASE

FIG. 19—COPE AND DRAG PATTERNS OF A STEARNS CRANK CASE

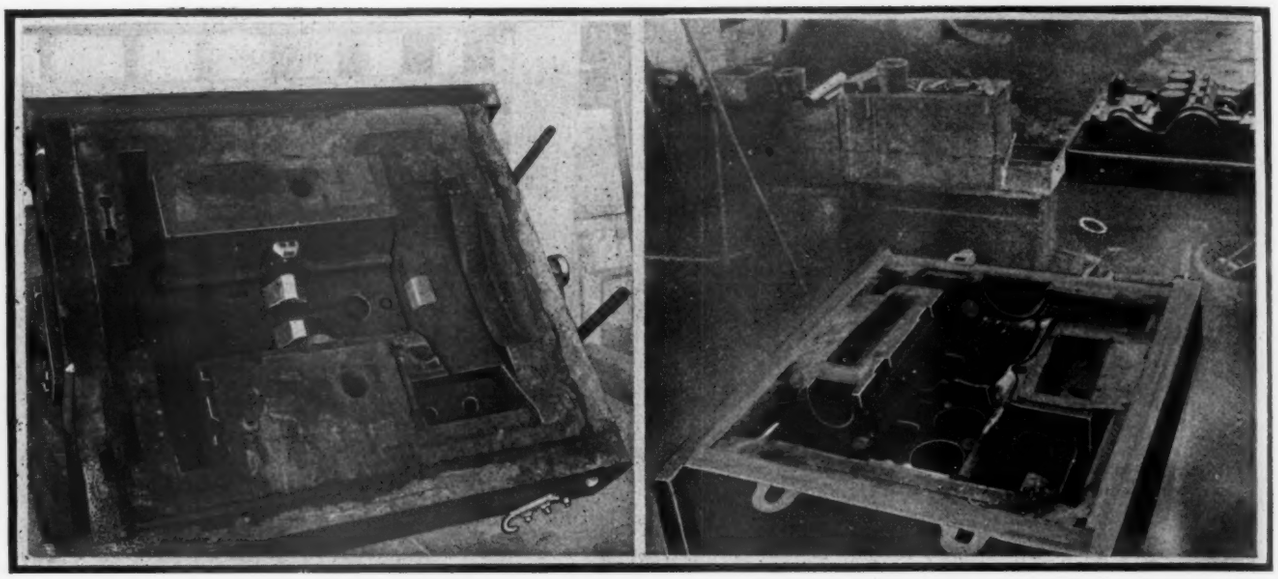


FIG. 20—COPE OF CRANK CASE MOLD

FIG. 21—DRAG OF CRANK CASE MOLD

Fig. 19. Some of the chills are shown in the cope in Fig. 20, and also in the drag, Fig. 21. The metal is poured from two sprues connecting with seven horn gates, and one large riser is provided.

Intricate Cores.

Some of the many intricate cores used in automobile work are shown in Fig. 17. These indicate that the designer of motor car parts has little regard for the difficulties of the foundryman, although it is gratifying to note that several of the leading manufacturers are simplifying their designs and are reducing intricate core work to the minimum. Two core ovens in the Buffalo plant, equipped with rolling lift doors are shown in Fig. 15. The mixtures for aluminum cores are similar to those used for brass, although it is necessary to have them somewhat softer than those required for the stronger metals. While both the molds and cores should be well vented, little gas is given off by the cores when pouring, which is due to the low temperature of the metal. Both rosin and linseed oil are used in the mixtures, while the molding sand is somewhat finer than that used for brass.

Repairing Defective Castings.

Burning-on is frequently resorted to, owing to the thin section of many of the castings, and miss-runs are occasional occurrences in all aluminum foundries. Burning-on is easily accomplished, but great care must be taken to prevent burning a still larger hole in the casting. The opening is backed by a flat surface, and sand is molded about the same. A flow-off is made and sufficient metal is poured to raise the temperature of the casting at this point to almost that of the molten aluminum. After the crucible has been emptied the sprue is permitted to remain on the casting until it has cooled, and is then sawed off.

Molding Automobile Bodies.

Automobile bodies in various stages of production are shown in Figs. 1, 2 and 3. In Fig. 1 the cope has just been lifted off, revealing the casting, which was poured through four sprues, and it can be seen that it is generously gated. The three parts of a mold for a motor car tonneau are shown in Fig. 3. The cheek rests on the horses on the left, the molder is slicking the drag in the foreground, and the cope is shown on the right.

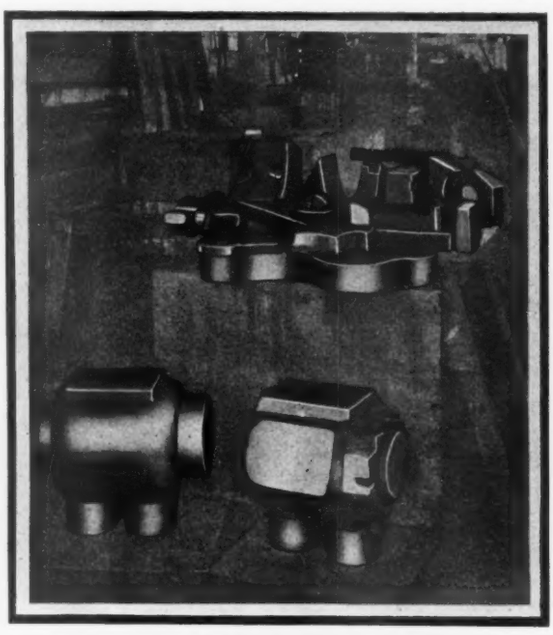


FIG. 22—INTRICATE CORES REQUIRED FOR THE CRANK CASE MOLD

The recent decline in the cost of aluminum has resulted in lower prices for castings, the average being about 40 cents per pound. When aluminum was selling at 50 cents the founders received 75 and 80 cents for the finished product. The casting of aluminum has been an inviting field of endeavor for many foundrymen, yet the percentage of successes has been comparatively small, owing to the many difficulties encountered, and the dissimilarity of the practice with that of any other branch of the foundry trade.

At the October meeting of the Associated Foundry Foremen of Philadelphia and vicinity, the subject of the education of apprentices was discussed at length and the manufacture of semi-steel castings was also considered. Officers for the ensuing year were nominated as follows: President, W. A. Perrine, Abram Cox Stove Co., Philadelphia; vice president, E. H. McCoy, Stanley G. Flagg & Co., Philadelphia; secretary, D. M. Kittenger, American Bridge Co., Pencoyd, Pa.; treasurer, C. M. Benkert, Fairmont Foundry Co., Philadelphia.

LATTER-DAY CUPOLA PRACTICE*

Methods of manipulating and operating the melting furnace of the gray iron foundry

BY E. E. RIEPEN

IN YEARS gone by it was customary to consider the cupola as a "mysterious thing," quite beyond the control of human beings. But those times have changed, and what once was the impossible, has yielded to the steady raps of insistent effort. Every year has marked an advance in the detail of cupola operations, until today we stand face to face with the scientific explanation of the once seemingly impossible. Yet, in comparison with achievements other metallurgical furnaces have made, it is forced to take second rank, not because of lack of effort, but because of lack of scientific investigation and correlation. Improvement is, however, fast being obtained, and before many years we may hope to see the cupola share in the glory of first place, where it belongs.

Condition for Successful Operation.

Let us consider the practical side and ask what are the conditions necessary to successful operations. There are many kinds of irons that may be obtained from the cupola; some may be quite soft, others quite hard, and both be desirable. The soft iron may be made from a mixture of entirely different composition from the hard mixture, and between these two limits exist all the important irons obtained from the cupola. With each of these different kinds of iron we must have temperature, that is, they must be melted hot enough to pour. To keep a cupola running hot, it must have fuel fed to it, and fed regularly and evenly. Coke, of course, is the common fuel, but what a perplexing question now confronts us. What is wanted and what is obtained mark the boundaries of a world of and by itself. Yet with a fairly good coke, which should run uniform as to composition and cellular structure, a good iron should be obtained.

Dry Coke.

What should be done, however, is to keep the coke dry. It is wrong to expect the cupola to work well and feed wet fuel into it. I will try to explain why wet fuel is detrimental. First, let us assume we wish a charge of 600 pounds of coke per charge of iron. If, as is possible, especially in winter where the coke is exposed to the weather, it contains as high as 33 1/3 per cent moisture, for every charge of 600 pounds of wet coke weighed, 200 pounds of it is water and only 400 pounds is coke that is serviceable to produce heat. Of this amount of heat produced, some of it is necessary to drive the 200 pounds of water out of the cupola, so that the actual amount of heat available to melt iron is still lowered by that amount. It naturally follows that, if a reduction of one-third of the amount of coke required to melt iron at the proper temperature was made, the iron obtained would be too dull to pour. There is a way by which this evil of wet coke may be overcome, which is both simple and easy to carry out. To do this it is only necessary to determine the amount of moisture the coke contains and make proper adjustment of the scale weight of coke per charge, to be added. This determination of the moisture content is very easy and simple; first, weigh out, say 10 pounds of the wet coke, put it in a hot oven or other warm place to dry. The loss in weight, as found by again weighing the coke, which of course is the dry coke, represents the amount of water that was present. It is only necessary then, to add extra coke to make up for this difference, so that when the coke descends in the cupola to the melting zone, there will be the requisite amount there to do the work intended for it. This method has been tried at several plants and has been found highly satisfactory. Of paramount importance is the condition of the coke as it enters the cupola to form the bed before lighting up. This coke should, by all means, be thoroughly dried; in fact so important is this item that whatever expense is incurred in drying this bed coke, is amply repaid by the good work it does.

Sulphur.

Another evil of the fuel is the ever present sulphur. The amount of sulphur absorbed by the iron from the fuel is not at all constant. It is an established fact that all the sulphur in the coke does not go into the iron, although the amount absorbed by the iron may render it unsuitable for the work in hand. Only a chemical analysis will determine the amount of sulphur a fuel may contain and still be safe as a fuel. While a good deal might be said as to the suitability of various brands of coke, I do not wish to dwell on this subject, as each cupola manager must settle that important question with his purchasing department.

The Proper Use of Coke.

Assuming the coke is of average quality, the manner in which it is to be used will next claim our attention. We add fuel for the heat units it gives up on combustion. It is also added to support the burden and to maintain the proper melting points. To do this, a careful watch of the melting conditions must be maintained. It is quite possible to spoil an otherwise good heat, by the improper feeding of the fuel. It should always be carefully leveled off after each charge is in the cupola, or slightly dished. By dished, I mean it should be drawn toward the outer edge or against the lining, leaving a slight hollow in the center. By charging in this manner, more resistance is offered to the blast, which escapes more or less freely around this part of the furnace. It sometimes happens that the coke bed in the melt-

*Presented at the October meeting of the Detroit Foundrymen's Association.

ing zone becomes uneven and it is at once necessary to rebuild it to the proper and uniform height. This can most effectively be done by adding a few hundred pounds of extra coke over the weak spots when only half of the regular iron charge is in the cupola, then finish charging the balance of that iron charge and proceed as usual. The extra coke is added when one-half of the iron charge is in the cupola to insure its being placed and retained in the proper position in the cupola. In a short time, depending on the speed of melting, this extra coke will be down to the melting zone and will very materially rebuild that part of the bed. It is very important, for economical reasons, that the melting proceed as even and regular as is possible, for the result of bad melting manifests itself throughout the entire plant, and is the cause of otherwise valuable castings being thrown out on the scrap heap.

Operation of the Cupola.

To keep the furnace open and free, for a long period of time, the dirt of the charges must be separated and removed from the iron. This is both easily and cheaply effected by adding a substance along with the charge that will unite with this foreign matter and become so fluid that it may be drawn from the cupola. The substance commonly employed is limestone, although other materials can be used. This limestone should be broken to about the size of eggs. There are many different grades of limestone and before a furnaceman can decide, intelligently, what is wanted, he should obtain a complete chemical analysis of the particular kind he desires to use. As the dirt, which usually finds its way into the cupola, is composed largely of sand or silica, and the limestone is added to flux this sand, it stands to reason that the less sand already in the limestone, the better is that stone for purifying purposes. Hence the importance of a chemical analysis, which at once shows the working powers of the stone. The use of limestone, however, is not altogether without limit, for too much stone is as bad, or worse, than too little. The repeated large doses of limestone is apt to cause the cupola to burn through the shell. The writer remembers one experience of this kind. He was working on a 100-inch cupola, lined to 81 inches at the melting zone, melting 22 tons of iron per hour for several consecutive hours, when the report came up that the cupola had gone through the shell. It was necessary to act quickly and this is what was done. About 16 or 18 lining brick were placed in the cupola on the top of the iron charge, over the place where the cupola had eaten its way through. These brick were allowed to descend along with the other charges. While they were descending, the hole (which was about four inches above the wind box) was stopped with mud and the outside cooled with a stream of water. When the brick reached this place they lodged in the depression of the lining, and were found there the next morning, having performed the work intended for them. The heat was finished successfully, after taking the blast off for about 10 minutes only, while mud was being placed in the hole. This is one of the bad effects produced by too much limestone. On this day we started on a new car of stone, using it at the old scale weight, without first having it analyzed, as the regular reserve of stone had been exhausted through difficulties of railroad transportation. As soon as we obtained information regarding the composition of the new stone, we saw the cause of our trouble, for it was a much richer stone, in lime, than what we had been accustomed to using.

Action of the Flux.

As the flux is added to form slag, it might be well at this time to trace the action of the stone in its descent through the cupola. When it reaches the first heated portion, a large quantity of gas is evolved. This is called carbon dioxide, or carbonic acid gas. The liberation of this gas frequently causes the stone to "pop" or explode, and is a good indication of how the cupola is utilizing the heat. If this "popping" occurs near the charging doors, it shows that the heating zone is too high in the cupola, and a great deal of heat is going up the stack which should be utilized in melting iron. To remedy this condition reduce the blast pressure and charge more compactly. After this gas in the stone has escaped, lime results. This remains as lime until a temperature approximating 1,800 degrees Fahr. is reached, when it combines with the sand and dirt—one pound of lime uniting with one, two or three pounds of sand, according to how the cupola is working. It is entirely possible to completely change the character of the slag. If the mixture carries a large percentage of sulphur which requires, let us say, 100 pounds of stone to produce a low sulphur iron, the stone effecting the removal of some sulphur, and we drop the amount of stone to 40 or 50 pounds per charge, or even less, the iron will be changed from soft to hard or even white iron. I refer to a heat of 10 or 12 hours' duration. For a heat of but an hour or so, little stone, if any, will be required, but for a heat of several hours or even days, special precautions must be taken, in order to keep the quality of the iron the same.

Heat Efficiency.

As the cupola is only a means of utilizing a given quantity of heat from a fuel, its efficiency depends on several conditions, every one of which is important. It must be lined correctly with the proper lining, must be thoroughly dried before being used, must conform to certain dimensions and must be handled carefully. The best brick made from silica sand should be used for lining, and the patching material should be of the best. This material or mud should be mixed dry, for a more intimate mixture can be obtained in this way, than when it is first wet and then mixed. Experience has proven that less fire clay is necessary, when handled this way, than when mixed wet. After mixing, it should be wet down and allowed to remain over night before using. In this way the plasticity of the clay is at its highest. It is not uncommon to go into a cupola a short time after patching up, and see the patching full of cracks where drying has set in. This allows an escape of heat from the melting zone and should not occur. It is very probable that the mud used for this patching was mixed or made up after first being wetted.

The Lining.

The form of lining should be regular and should not have offsets in its contour. It should be kept to as near a standard form as is possible; this form to be determined by careful experimenting with each cupola, as no two cupolas work exactly alike. As to the dimensions of a cupola, of course the work to be done must be considered, but it is better to get a larger cupola and line it down to the size wanted, than try to force a smaller one, for a greater saving of heat is obtained with thicker walls than with thin ones. The combined tuyere area should be at least equal to the cross sectional area of the wind box, and the blast pipe of sufficient

THE FOUNDRY DATA SHEET, DECEMBER, 1908.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

TABLE SHOWING THE AMOUNT OF STEEL IN LADLES AT VARIOUS DEPTHS.

DIAMETER OF LADLE AT THE BOTTOM IN INCHES.

Steel in ladle inches.	20	20½	21	21½	22	22½	23	23½	24	24½	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
1	85	89	93	98	102	107	112	117	122	127	132	143	154	166	178	190	203	216	230	244	259	274	289	305	321	338	355	372	390	409	427
2	171	179	188	197	206	215	225	235	245	255	266	287	310	333	357	382	408	434	462	490	519	549	580	612	644	678	712	747	783	820	857
3	257	270	283	297	311	325	339	354	369	385	401	433	467	502	538	575	614	654	695	738	782	827	873	921	970	1,020	1,071	1,124	1,178	1,233	1,289
4	345	363	380	398	417	436	455	475	495	516	537	580	625	672	720	770	822	875	931	988	1,046	1,106	1,168	1,232	1,297	1,364	1,432	1,503	1,575	1,648	1,724
5	434	456	478	501	524	548	572	597	622	648	674	729	785	843	904	967	1,032	1,099	1,168	1,239	1,312	1,388	1,465	1,545	1,626	1,710	1,796	1,884	1,974	2,066	2,161
6	524	550	577	604	632	661	690	720	750	781	813	878	946	1,016	1,090	1,165	1,243	1,324	1,407	1,492	1,580	1,671	1,764	1,860	1,958	2,059	2,162	2,268	2,376	2,487	2,600
7	615	646	677	709	742	775	810	844	880	916	953	1,030	1,109	1,191	1,277	1,365	1,456	1,550	1,647	1,747	1,850	1,956	2,065	2,177	2,291	2,409	2,530	2,653	2,780	2,909	3,042
8	708	743	778	815	852	891	930	970	1,011	1,052	1,095	1,182	1,273	1,368	1,465	1,566	1,671	1,778	1,890	2,004	2,122	2,243	2,368	2,496	2,627	2,762	2,900	3,041	3,186	3,334	3,486
9	801	840	881	922	964	1,008	1,052	1,097	1,143	1,190	1,238	1,336	1,439	1,545	1,655	1,769	1,887	2,008	2,134	2,263	2,396	2,533	2,673	2,817	2,965	3,117	3,272	3,432	3,596	3,762	3,932
10	895	939	984	1,030	1,077	1,126	1,175	1,225	1,276	1,329	1,382	1,492	1,606	1,725	1,847	1,974	2,105	2,240	2,380	2,523	2,671	2,823	2,980	3,140	3,305	3,474	3,647	3,824	4,006	4,191	4,381
11	991	1,039	1,089	1,140	1,192	1,245	1,299	1,354	1,411	1,469	1,528	1,649	1,775	1,906	2,040	2,180	2,325	2,474	2,628	2,786	2,949	3,116	3,288	3,463	3,647	3,833	4,024	4,219	4,419	4,623	4,833
12	1,088	1,141	1,195	1,250	1,307	1,365	1,425	1,485	1,547	1,610	1,675	1,807	1,945	2,088	2,235	2,388	2,546	2,709	2,877	3,050	3,228	3,411	3,599	3,792	3,991	4,194	4,403	4,616	4,834	5,058	5,287
13	1,185	1,243	1,302	1,362	1,424	1,487	1,552	1,617	1,685	1,753	1,823	1,967	2,116	2,271	2,432	2,598	2,769	2,946	3,128	3,316	3,509	3,708	3,912	4,122	4,337	4,558	4,784	5,015	5,252	5,495	5,743
14	1,284	1,346	1,410	1,475	1,542	1,610	1,680	1,751	1,823	1,897	1,973	2,128	2,290	2,457	2,630	2,809	2,994	3,185	3,381	3,584	3,792	4,007	4,227	4,453	4,685	4,923	5,167	5,417	5,672	5,934	6,201
15	1,384	1,451	1,519	1,590	1,661	1,734	1,809	1,885	1,963	2,043	2,124	2,291	2,464	2,644	2,830	3,022	3,220	3,425	3,636	3,854	4,077	4,308	4,544	4,787	5,036	5,291	5,553	5,821	6,095	6,376	6,663
16	1,485	1,557	1,630	1,705	1,782	1,860	1,940	2,021	2,105	2,190	2,277	2,455	2,460	2,832	3,031	3,236	3,448	3,667	3,893	4,125	4,365	4,610	4,863	5,122	5,385	5,661	5,940	6,227	6,520	6,819	7,126
17	1,587	1,664	1,742	1,822	1,903	1,987	2,072	2,159	2,248	2,338	2,430	2,620	2,818	3,022	3,234	3,452	3,678	3,911	4,152	4,399	4,653	4,915	5,184	5,460	5,743	6,033	6,331	6,635	6,947	7,266	7,592
18	1,691	1,772	1,855	1,939	2,026	2,115	2,205	2,297	2,392	2,487	2,586	2,789	2,987	3,214	3,438	3,670	3,910	4,157	4,412	4,674	4,946	5,222	5,507	5,800	6,100	6,407	6,723	7,046	7,377	7,715	8,060
19	1,795	1,881	1,969	2,058	2,150	2,244	2,339	2,437	2,537	2,639	2,742	2,956	3,177	3,407	3,644	3,890	4,143	4,405	4,674	4,952	5,237	5,530	5,831	6,141	6,459	6,784	7,117	7,459	7,808	8,166	8,531
20	1,901	1,991	2,084	2,179	2,276	2,375	2,476	2,579	2,684	2,791	2,901	3,126	3,360	3,602	3,852	4,111	4,378	4,654	4,938	5,231	5,532	5,841	6,159	6,485	6,820	7,163	7,514	7,874	8,243	8,620	9,005
21	2,008	2,103	2,201	2,300	2,402	2,506	2,613	2,721	2,832	2,945	3,060	3,297	3,543	3,798	4,061	4,334	4,615	4,905	5,204	5,512	5,828	6,154	6,488	6,831	7,183	7,544	7,913	8,292	8,679	9,076	9,481
22	2,116	2,216	2,318	2,423	2,530	2,639	2,751	2,865	2,982	3,100	3,221	3,470	3,728	3,996	4,272	4,558	4,853	5,158	5,472	5,795	6,127	6,468	6,819	7,179	7,548	7,927	8,315	8,712	9,118	9,534	9,959
23	2,225	2,330	2,437	2,547	2,659	2,774	2,891	3,011	3,132	3,257	3,384	3,644	3,915	4,195	4,485	4,784	5,094	5,413	5,741	6,080	6,428	6,785	7,153	7,529	7,916	8,312	8,719	9,134	9,559	9,995	10,440
24	2,335	2,445	2,557	2,672	2,790	2,910	3,032	3,157	3,285	3,415	3,547	3,820	4,103	4,396	4,699	5,012	5,336	5,669	6,013	6,366	6,730	7,104	7,488	7,881	8,285	8,700	9,124	9,559	10,003	10,458	10,922
25	2,447	2,561	2,679	2,799	2,922	3,047	3,175	3,305	3,438	3,574	3,713	3,997	4,293	4,599	4,915	5,242	5,579	5,927	6,286	6,655	7,034	7,425	7,825	8,236	8,658	9,090	9,532	9,985	10,450	10,923	11,409
26	.....	.....	2,801	2,927	3,054	3,185	3,318	3,455	3,593	3,735	3,879	4,176	4,484	4,803	5,133	5,473	5,825	6,187	6,561	6,945	7,341	7,747	8,164	8,593	9,032	9,482	9,943	10,415	10,898	11,392	11,897
27	.....	.....	.....	.....	3,189	3,324	3,464	3,605	3,750	3,897	4,047	4,357	4,677	5,009	5,353	5,708	6,072	6,449	6,838	7,238	7,649	8,071	8,506	8,951	9,408	9,876	10,356	10,847	11,349	11,862	12,388
28	.....	.....	.....	.....	.....	.....	3,610	3,757	3,908	4,061	4,217	4,538	4,871	5,216	5,572	5,941	6,321	6,713	7,117	7,532	7,959	8,398	8,849	9,312	9,786	10,273	10,771	11,280	11,802	12,335	12,880
29	.....	.....	.....	.....	.....	.....	.....	.....	4,067	4,226	4,388	4,721	5,067	5,425	5,795	6,177	6,752	6,978	7,397	7,828	8,271	8,728	9,195	9,675	10,167	10,671	11,188	11,717	12,258	12,811	13,376
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,561	4,906	5,265	5,636	6,019	6,415	6,824	7,246	7,680	8,127	8,586	9,058	9,542	10,040	10,550	11,072	11,608	12,155	12,716	13,289	13,874
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,093	5,464	5,848	6,245	6,655	7,079	7,515	7,964	8,427	8,903	9,391	9,893	10,407	10,935	11,476	12,030	12,596	13,176	13,770	14,378	
32	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,664	6,062	6,473	6,897	7,335	7,786	8,251	8,729	9,221	9,726	10,245	10,776	11,323	11,881	12,454	13,040	13,639	14,252	14,878	
33	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,277	6,702	7,140	7,593	8,059	8,539	9,033	9,541	10,063	10,598	11,148	11,712	12,289	12,880	13,486	14,105	14,738	15,385	
34	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,933	7,385	7,852	8,334	8,829	9,339	9,863	10,402	10,955	11,522	12,103	12,699	13,310	13,934	14,573	15,225	15,893	
35	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,632	8,114	8,610	9,121	9,647	10,187	10,743	11,313	11,898	12,497	13,111	13,741	14,384	15,042	15,716	16,403		
36	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,881	8,377	8,889	9,415	9,957	10,514	11,086	11,674	12,276	12,893	13,526	14,174	14,837	15,516	16,208	16,917	
37	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,642	9,169	9,711	10,269	10,843	11,431	12,036	12,656	13,292	13,943	14,610	15,292	15,991	16,704	17,433		
38	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9,481	10,059	10,583	11,173	11,779	12,401	13,038	13,692	14,362	15,048	15,750	16,467	17,201	17,951		
39	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,309	10,899	11,505	12,128	12,767	13,423	14,095	14,784	15,489	16,210	16,948	17,702	18,473		
40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	11,216	11,840	12,480	13,136	13,809	14,501	15,207	15,932	16,673	17,431	18,204	18,996		
41	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12,177	12,833	13,507	14,199	14,907	15,633	16,376	17,138	17,915	18,710	19,522		
42	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13,188	13,880	14,590	15,317	16,062	16,824	17,604	18,402	19,218	20,051			
43	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14,256	14,983	15,729	16,493	17,274	18,074	18,892	19,728	20,582			
44	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	15,379	16,143	16,926	17,726	18,546	19,384	20,240	21,116			
45	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	16,559	17,361	18,181	19,021	19,879	20,756	21,653			
46	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17,798	18,638	19,497	20,376	21,274	22,191			
47	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	18,239	19,097	19,977	20,876	21,794	22,734			
48	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	19,560	20,458	21,378	22,317	23,278			
49	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20,944	21,883	22,844	23,825			
50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	22,390	23,372	24,374			
51	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	23,902	24,926			
52	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	25,481			

TABLE SHOWING THE CAPACITY OF STEEL LADLES AT EACH INCH OF THEIR DEPTH. RISE IN DIAMETER 1½ INCHES PER FOOT. LADLES FROM 2,500 TO 25,000 POUNDS CAPACITY

(Continued on Data Sheet, No. 32.)

DATA SHEET, No. 31, THE FOUNDRY, DECEMBER, 1908

(Continued From Data Sheet, No. 31.)

TABLE SHOWING THE AMOUNT OF STEEL IN LADLES AT VARIOUS DEPTHS.

DIAMETER OF LADLE AT THE BOTTOM IN INCHES.

Steel in ladle inches.	45	46	47	48	49	50	51	52	53	54	55
1	446	466	486	506	527	549	570	592	614	637	659
2	895	935	975	1,016	1,058	1,101	1,144	1,188	1,233	1,278	1,324
3	1,347	1,406	1,467	1,528	1,591	1,656	1,721	1,787	1,855	1,923	1,993
4	1,802	1,881	1,962	2,044	2,128	2,214	2,301	2,390	2,480	2,572	2,665
5	2,259	2,358	2,459	2,562	2,667	2,774	2,883	2,994	3,107	3,222	3,338
6	2,717	2,836	2,958	3,081	3,207	3,335	3,466	3,599	3,734	3,871	4,011
7	3,178	3,317	3,459	3,603	3,751	3,900	4,053	4,208	4,366	4,527	4,690
8	3,641	3,800	3,961	4,126	4,294	4,465	4,639	4,816	4,996	5,179	5,365
9	4,107	4,285	4,466	4,650	4,838	5,029	5,224	5,422	5,624	5,829	6,038
10	4,576	4,774	4,977	5,183	5,394	5,608	5,826	6,048	6,274	6,503	6,737
11	5,047	5,265	5,490	5,718	5,952	6,189	6,431	6,677	6,927	7,182	7,441
12	5,520	5,759	6,005	6,256	6,512	6,772	7,039	7,309	7,585	7,865	8,150
13	5,996	6,255	6,523	6,797	7,074	7,358	7,648	7,943	8,244	8,550	8,862
14	6,474	6,754	7,044	7,340	7,640	7,947	8,260	8,580	8,906	9,239	9,578
15	6,955	7,257	7,568	7,886	8,209	8,539	8,875	9,219	9,570	9,929	10,296
16	7,439	7,763	8,096	8,435	8,781	9,134	9,494	9,862	10,238	10,622	11,015
17	7,926	8,273	8,628	8,988	9,356	9,732	10,116	10,508	10,909	11,319	11,737
18	8,416	8,786	9,164	9,545	9,936	10,334	10,742	11,158	11,584	12,019	12,463
19	8,909	9,302	9,703	10,107	10,520	10,941	11,371	11,812	12,262	12,722	13,192
20	9,404	9,821	10,245	10,673	11,108	11,552	12,004	12,469	12,944	13,429	13,926
21	9,904	10,344	10,790	11,242	11,701	12,168	12,642	13,131	13,630	14,141	14,664
22	10,406	10,870	11,338	11,814	12,298	12,788	13,287	13,797	14,320	14,857	15,406
23	10,911	11,399	11,890	12,389	12,898	13,413	13,939	14,467	15,015	15,577	16,152
24	11,419	11,931	12,445	12,968	13,501	14,042	14,594	15,161	15,743	16,301	16,902
25	11,930	12,466	13,004	13,551	14,107	14,675	15,253	15,850	16,474	17,029	17,656
26	12,444	13,004	13,567	14,137	14,717	15,312	15,917	16,542	17,208	17,761	18,414
27	12,961	13,545	14,133	14,727	15,331	15,953	16,585	17,238	17,946	18,497	19,176
28	13,481	14,089	14,702	15,321	15,950	16,598	17,257	17,938	18,688	19,237	19,942
29	14,004	14,636	15,274	15,919	16,573	17,247	17,933	18,642	19,434	19,981	20,712
30	14,530	15,186	15,850	16,521	17,200	17,900	18,613	19,350	20,184	20,729	21,486
31	15,059	15,739	16,430	17,127	17,831	18,557	19,298	20,062	20,938	21,481	22,264
32	15,591	16,295	17,013	17,736	18,466	19,218	19,987	20,778	21,696	22,237	23,046
33	16,126	16,855	17,599	18,349	19,105	19,883	20,680	21,498	22,458	22,997	23,832
34	16,664	17,419	18,189	18,966	19,748	20,552	21,377	22,222	23,224	23,761	24,623
35	17,205	17,987	18,783	19,586	20,395	21,225	22,078	22,950	23,994	24,529	25,419
36	17,749	18,558	19,381	20,209	21,046	21,902	22,783	23,682	24,768	25,301	26,219
37	18,296	19,132	19,983	20,836	21,701	22,584	23,492	24,418	25,546	26,077	27,023
38	18,846	19,709	20,588	21,467	22,360	23,270	24,205	25,158	26,328	26,857	27,831
39	19,399	20,289	21,196	22,102	23,023	23,960	24,922	25,903	27,114	27,641	28,643
40	19,955	20,872	21,807	22,741	23,690	24,654	25,643	26,652	27,904	28,429	29,459
41	20,514	21,458	22,422	23,384	24,360	25,352	26,368	27,405	28,698	29,221	30,279
42	21,076	22,047	23,041	24,031	25,034	26,054	27,098	28,162	29,496	30,017	31,103
43	21,641	22,639	23,663	24,681	25,712	26,760	27,832	28,923	30,298	30,817	31,931
44	22,209	23,234	24,288	25,334	26,394	27,470	28,570	29,688	31,104	31,621	32,763
45	22,780	23,832	24,916	25,991	27,080	28,184	29,312	30,457	31,914	32,429	33,599
46	23,354	24,433	25,548	26,652	27,770	28,902	30,058	31,230	32,728	33,241	34,439
47	23,931	25,037	26,183	27,317	28,464	29,624	30,808	32,007	33,546	34,057	35,283
48	24,511	25,644	26,821	27,986	29,162	30,350	31,562	32,788	34,368	34,877	36,131
49	25,094	26,254	27,463	28,659	29,864	31,080	32,320	33,573	35,194	35,701	36,983
50	25,680	26,868	28,108	29,335	30,570	31,814	33,082	34,362	36,024	36,529	37,839
51	26,269	27,485	28,756	30,014	31,279	32,552	33,848	35,155	36,858	37,361	38,699
52	26,861	28,105	29,407	30,696	31,992	33,293	34,618	35,952	37,696	38,197	39,563

TABLE SHOWING CAPACITY OF STEEL LADLES AT EACH INCH OF THEIR DEPTH
LADLES FROM 25,000 TO 50,000 POUNDS CAPACITY

Steel in ladle inches.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
1	1,259	1,312	1,368	1,425	1,484	1,545	1,607	1,671	1,737	1,805	1,874	1,945	2,018	2,093	2,170	2,249	2,330	2,413	2,498	2,585	2,674	2,765	2,858	2,953	3,050	3,149	3,250	3,353	3,458	3,565	3,674	3,785	3,898	4,013	4,130	4,249	4,370	4,493	4,618	4,745	4,874	5,005	5,138	5,273	5,410	5,549	5,690	5,833	5,978	6,125
2	2,518	2,624	2,735	2,849	2,967	3,089	3,214	3,342	3,474	3,610	3,748	3,890	4,035	4,185	4,339	4,497	4,659	4,825	4,995	5,169	5,347	5,529	5,715	5,905	6,099	6,297	6,499	6,705	6,915	7,129	7,347	7,569	7,795	8,025	8,259	8,497	8,739	8,985	9,235	9,489	9,747	10,009	10,275	10,545	10,819	11,097	11,379	11,665	11,955	12,249
3	3,777	3,936	4,102	4,274	4,451	4,634	4,821	5,013	5,211	5,415	5,622	5,835	6,053	6,277	6,508	6,746	6,988	7,238	7,493	7,754	8,021	8,294	8,573	8,858	9,149	9,446	9,749	10,058	10,373	10,694	11,021	11,354	11,693	12,038	12,389	12,746	13,109	13,478	13,853	14,234	14,621	15,014	15,413	15,818	16,229	16,646	17,069	17,499	17,934	18,374
4	5,036	5,248	5,469	5,698	5,934	6,178	6,428	6,684	6,948	7,220	7,496	7,780	8,070	8,369	8,677	8,994	9,317	9,650	9,990	10,338	10,695	11,059	11,430	11,811	12,198	12,595	12,998	13,410	13,830	14,258	14,694	15,138	15,590	16,050	16,518	16,994	17,479	17,970	18,471	18,979	19,495	20,018	20,550	21,090	21,638	22,194	22,758	23,332	23,912	24,499
5	6,295	6,560	6,836	7,123	7,417	7,723	8,035	8,355	8,685	9,025	9,370	9,725	10,088	10,461	10,846	11,243	11,646	12,063	12,488	12,923	13,369	13,824	14,288	14,764	15,248	15,744	16,248	16,763	17,288	17,823	18,368	18,923	19,488	20,063	20,648	21,243	21,849	22,463	23,089	23,724	24,369	25,023	25,688	26,363	27,048	27,743	28,448	29,165	29,890	30,624
6	7,554	7,872	8,203	8,548	8,900	9,268	9,642	10,026	10,422	10,830	11,244	11,670	12,106	12,553	13,015	13,492	13,975	14,476	14,986	15,508	16,043	16,589	17,146	17,717	18,298	18,893	19,498	20,116	20,746	21,388	22,042	22,708	23,386	24,076	24,778	25,492	26,219	26,956	27,707	28,469	29,243	30,028	30,826	31,635	32,458	33,292	34,138	34,998	35,868	36,749
7	8,813	9,184	9,571	9,973	10,383	10,813	11,249	11,697	12,159	12,635	13,118	13,615	14,123	14,646	15,184	15,740	16,304	16,889	17,484	18,092	18,717	19,354	20,003	20,670	21,348	22,041	22,748	23,470	24,205	24,953	25,724	26,493	27,284	28,088	28,907	29,741	30,589	31,449	32,326	33,214	34,118	35,036	35,969	36,910	37,868	38,841	39,827	40,831	41,848	42,882
8	10,072	10,496	10,938	11,398	11,867	12,358	12,856	13,368	13,896	14,440	14,992	15,560	16,141	16,738	17,353	17,987	18,633	19,302	19,981	20,677	21,391	22,126	22,860	23,634	24,398	25,190	26,000	26,827	27,663	28,527	29,406	30,278	31,180	32,100	33,035	33,988	34,960	35,949	36,955	37,979	39,020	40,078	41,153	42,244	43,353	44,480	45,624	46,786	47,965	49,162
9	11,331	11,808	12,305	12,823	13,350	13,903	14,463	15,039	15,633	16,245	16,866	17,505	18,163	18,830	19,522	20,234	20,962	21,715	22,479	23,262	24,063	24,892

size to carry all the air that the furnace would ever require.

The Blast.

As we have come to the important subject of blast, we will dwell somewhat at length on the uses and abuses of this element. The blast, or air, is composed of 21 parts oxygen, 77 parts nitrogen, with the other two remaining parts consisting of aqueous vapor, carbonic acid gas, and fumes of different substances, according to location. For our purposes, however, we may confine ourselves to the three first mentioned, oxygen being the most important. This oxygen uniting with the fuel is what produces the heat, and the regulation of this oxygen regulates, to a certain extent, the amount of heat produced. For every pound of coke burned to complete combustion, 150 cubic feet of air is required, and in good practice, one pound of coke will melt nine pounds of iron, so that to melt one pound of iron, 16 pounds of air will be necessary, or about 32,000 cubic feet per ton of iron melted. This air is heated by passing through the incandescent coke and carries that heat upward, heating the stack above the melting zone and finally passes out at the top of the stack. If the rate of driving be so fast as to drive more air into the cupola than is required to melt with, a larger loss of heat occurs. This extra amount of heat will be taken from the iron, where it belongs, and thus lower the temperature at which the iron is melted. Additional fuel, in this case, is of no benefit, as the amount of fuel that can be used is limited to the dimensions of the cupola, so that to drive the blast faster than the cupola can take care of it results in a greater loss than would, at first thought, be considered possible.

Blast Pressure.

The pressure should very seldom be higher than 18 ounces, and a lower blast is desirable, say 14 ounces or even 12 ounces. In order to determine the proper blast pressure for a given cupola, samples should be taken of the gases, about a foot below the charging doors, and a chemical analysis made. This sampling should be done while the cupola is running normally and should extend over two or three days time. When once the proper maximum pressure, suitable for a given cupola, is obtained, it should be a strict rule of the foundryman never to allow the pressure to exceed that amount. He thus not only receives more uniform iron, but more economical melting, in being able to utilize more heat than he otherwise could. This is quite evident from the following figures: On a heat of 100 tons per day, 3,200,000 cubic feet of air will be required. Should more than this amount be forced into the cupola it would only carry heat away. Let us say, for argument, that 1,000,000 cubic feet of air was forced into the furnace, over and above the amount actually required. Let us again say that the temperature at which the air leaves the charges at the charging doors is 325 degrees Fahr., and that the temperature of the blast entering cupola was 25 degrees Fahr. Then, reducing the excess air to pounds, multiplying by a specific heat and dividing by 12,000 B. T. U. (average available heat units from one pound of foundry coke) we find it takes 760 pounds of dry coke to supply the heat carried away by this excess blast. In other words, forcing an excess of 600,000 cubic feet of air per day carries away the heat liberated by 760 pounds of coke. Extending this for a year of 300 working days, we have an enormous total of 228,000 pounds of wasted fuel, enough to melt 1,026 tons of iron. This perhaps is more than actually occurs in practice, but has purposely been made large in order to show how big an item of waste heat might result. To avoid this useless expenditure, a careful comparison of working conditions, day by day, should be kept, and it is a most excellent plan to plot these different conditions on cross section paper. In that way a very ready observation may be made and frequently shows the furnaceman conditions existing, that could have gone by unnoticed.

Mixtures.

One of the most, if not the most, important question that bothers a cupola manager, is that of the mixture. It is necessary to obtain a mixture that will produce the castings desired, and in the attempt to meet competition as to quality, foundrymen generally use a large percentage of pig iron in their mixture. Some managers go so far as not to allow the use of their own scrap, while others may be more lenient and permit a small percentage of their own scrap in the charge. As to the use of pig iron there can be no question, but it is not necessary to confine oneself to pig iron exclusively. In fact some mixtures are much better without a large amount of pig iron present. At one of the largest foundries in the country, making a high class article, it is seldom that the pig iron is allowed to reach as high as 25 per cent of the total charge, yet their product withstands shocks and strains that few castings are called upon to endure. The balance of that mixture is made up of scrap. When once the theory of mixing iron is understood, it is not hard to obtain a casting fully representative of the estimated analysis.

Chemical Analysis.

Permit me to say here that by the use of chemical analysis, many seemingly impossible things are brought about. So great is the standing of the chemical laboratory among the foremost foundries, that it would be useless to try to dissuade them from its benefits. In no other way can so uniform a quality of iron be produced and, when once the foundryman decides to employ the information unfolded by a careful analysis, he seldom goes back to the old way of "hit and miss." It is because of lack of opportunities embraced that the author mentioned the fact that the cupola was forced to take second place in the field of metallurgical furnaces. Let me show what it means to use the laboratory. At one foundry, making car wheels, a saving of $10,000 per year was made. This was effected by carefully watching the market prices of material and employing a chemist to calculate the mixtures according to these market prices. If one kind of scrap increased in price, the amount used per charge was decreased and the kind of scrap which was less in price substituted. This substitution was immediately followed by a chemical analysis of the castings, and any variations noted in the mixture could be quickly corrected. I am dwelling somewhat at length on the importance of the chemical analysis, for the chemist is the best friend a foundryman has, and he is the man who can save many a dollar for the founder that would otherwise be lost.

Elements in the Mixture.

Now as to the composition of the mixture and how obtained. First it will be well to review the elements commonly occurring in cast iron. These are the carbon (hardening and graphitic), silicon, sulphur, manganese and phosphorus. The carbons are

controlled largely by the silicon; sulphur effects the silicon by neutralizing its effects on the carbons; manganese is antagonistic to the action of sulphur and may even go so far as to eliminate a large portion of it; phosphorus is there by right of way and resists all efforts at elimination. As to the desirable amount of each of these elements, only individual castings will determine; yet there is a limit, both maximum and minimum, which should be regarded. For instance, silicon should be present to some extent in order that the carbons may become separated. In chilled castings, for frictional wear, sulphur should be fairly high in order to produce a very high wearing surface. For car wheel work, sulphur may be as high as 0.180 per cent and not be detrimental, but for soft work the sulphur should be kept below 0.10 per cent. This low sulphur permits the silicon to separate the carbons, or strictly speaking, allows more hardening carbon to change to graphitic form which might as well be called softening carbon. Each of these elements has an effect on the shrinkage of the castings. One striking peculiarity is the fact that the great influence of combined carbon on shrinkage. In no other element do we find so great a power over shrinkage. Increasing this combined carbon increases shrinkage, manganese reduces it as does silicon. Sulphur also increases it, but may be controlled somewhat by manganese. Without going any further into the effects of the elements on the physical qualities of the metal, I would say that to be able to produce good castings, an understanding of these effects should be obtained. It is by this means that the status of gray iron may reach the high standard that its brother, cast steel, has attained. There are no less possibilities for gray iron than for steel, but it will require the united efforts of intelligent men to raise the standard of cast iron castings to a point approaching the quality of steel castings. Careful operations of detail work in and around the cupola will very greatly tend to a more uniform product, and the time will not be far distant when the cupola will force the steel castings to find new pastures, and the thanks of it all will be to those foundrymen whose hearts have been in the work and who are not satisfied with less than the best.

A MOLDING SAND MIXER.

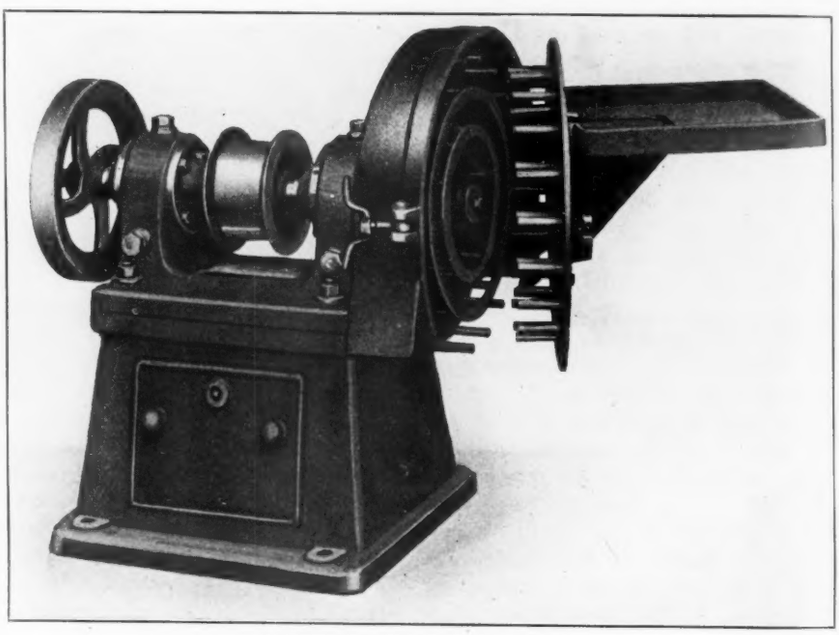
By Dr. Alfred Gradenwitz

Molding sand mixers are one of the most important auxiliaries of a sand dressing plant, their function being to crush the coarse particles contained in the sand and insure a mixing of the material that will be as uniform as possible. Sand so treated is mixed with air and a very loose and dry material is obtained, which, however, has the required consistency. Molds prepared with such sand will be both resistant to heat and permeable to the air, thus guaranteeing a most successful casting and smooth surfaces. In manufacturing large quantities with molding machines, a sand mixer thus is a really indispensable attachment for obtaining a suitable molding sand.

The accompanying illustration shows a German molding sand mixer, which is manufactured by Ph. Löhe, at Hennef, a. d. Sieg, Germany. In this machine the spindle is carried in dust-proof boxes, with ring-lubricated spherical bronze bearings. The belt pulley is between the bearings, and a movable peg disc is keyed loosely to the spindle. In front of this disc is located the stationary peg disc, comprising a number of concentric rings, which are attached to the lid of the mixing box. The lid is provided with an admission opening, and in order to inspect the pegs, is swung on hinges.

A flywheel is mounted at the opposite end of the shaft from the peg disc, and insures a uniform load on the bearings. This results in smooth running, increased capacity and a saving of energy.

The mixer is mounted on a cast iron base, which also serves as a tool box. The machine is made in two sizes, with outputs of 35 and 70 cubic feet per hour, respectively, of a uniformly mixed and loose molding sand. These two sizes weigh 1,125 and 1,650 pounds, respectively.



A German Molding Sand Mixer

WARPED REGISTER CASTINGS.

By W. J. Keep

Question:—We are experiencing considerable trouble with the warping of register castings which have flanges 2⅛ inchs wide and ¼ inch thick on all four sides. The open center of the register is divided into 4-inch squares by bars ¼-inch square. As soon as the registers have been cast the center of the lattice work rises and warps the outside flanges.

Answer.—You should arrange to have the flange cool as quickly as the center of the registers. Probably the best method is to remove the sand from the edges of the castings just as soon as the iron is set, and the gates should be broken off before the iron is uncovered. The sand, however, should be left over the center of the register where the iron is very thin.

HIGH TENSILE LEAD ALLOY.

A patent has recently been granted on a lead alloy for which high tensile strength is claimed, and which is said to be especially useful for lead pipes. It contains from three-fourths to 5 per cent of zinc, the balance being lead. The only claim, however, refers to from 1, 4 to 5 per cent of zinc.

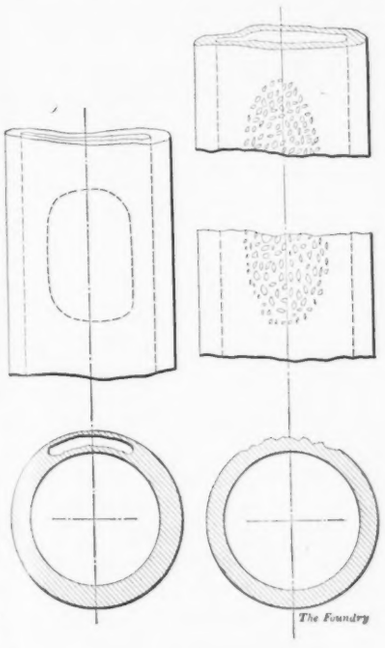
THE PREVENTION OF WASTER CASTINGS

A comprehensive discussion of the causes that result in defective castings --- Blow Holes --- Venting --- Shrinkage --- Repairs

BY JOSEPH HORNER

WASTERS are the perennial scares of the molder. They often occur in an epidemic fashion, a long run of good luck alternating with spells of bad. "It never rains, but it pours" is an often expressed sentiment in the foundry, for one or two bad castings are almost sure to be quickly followed by others, in the experience of most men.

Most molders have some belief in luck, and in truth it is often difficult to disabuse the mind of this sentiment, since the causes which produce bad castings are often obscure. There is always a cause, of course, but it is not always readily detected and ascertained with certainty, so slight and often apparently unimportant are the causes which produce bad results. Some causes are cumulative, like the loss of a nail in the horse shoe which resulted in a long list of calamities. If we were to attempt to indicate all of these we would have to go through all the operations in the craft of the molder and founder, for there is not one which does not bear its share in the production of bad castings. Choice of sand, methods of ramming and venting, coring, methods of pouring, quality and temperature of metal, etc.



FIGS. 1 AND 2—CASTING WITH A LARGE BLOW HOLE. THE SURFACE OF THE OTHER CASTING IS BADLY HONEYCOMBED

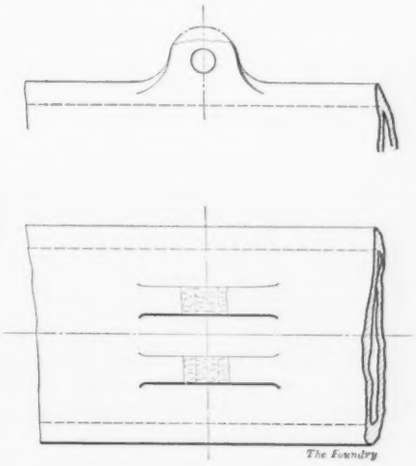


FIG. 3—LUGS OF CASTINGS HONEYCOMBED

Errors of judgment and of practice in either of these are liable to produce waster castings. Obscurity, however, often stands in the way of a ready appreciation of the causes which result in bad work. Everything is not so clear and evident, as, say, the shifting of a core, the blowing of a core, imperfect venting, the washing away of sand, scabbing, bad proportioning and other evils.

Defective Castings in the Jobbing Foundry.

The jobbing molder is especially liable to make bad castings. When a man is doing the same class of work for a long time he learns how to avoid the things that make for bad castings. But the man who handles different classes of work from day to day has to learn the little ins and outs of it all, the pitfalls and risks attached to his work. A man who has had wide experience in jobbing molding feels vastly more confidence in attempting novel jobs than a mere specialist does, and will generally get through them without mishap. But of course the unforeseen does sometimes happen, and then the why and wherefore has to be ascertained.

Confined Gases.

Probably the largest number of wasters produced in the foundry are caused by the presence of air in cores and molds. Metal and air cannot occupy the same space, and therefore if the air cannot get away, the metal cannot get in. This affects both cores and molds, but it affects various classes of molds differently. The conditions are very unlike in green and dry sand mixtures, and loam work again is a class by itself. The differences are partly due to the various mixtures of sands, partly to the presence in, or the degree of elimination of the moisture from the molds. Though cores may be amply vented, many wasters occur because the vents are not properly connected or secured to the outside of the mold, or because they are not properly ce-

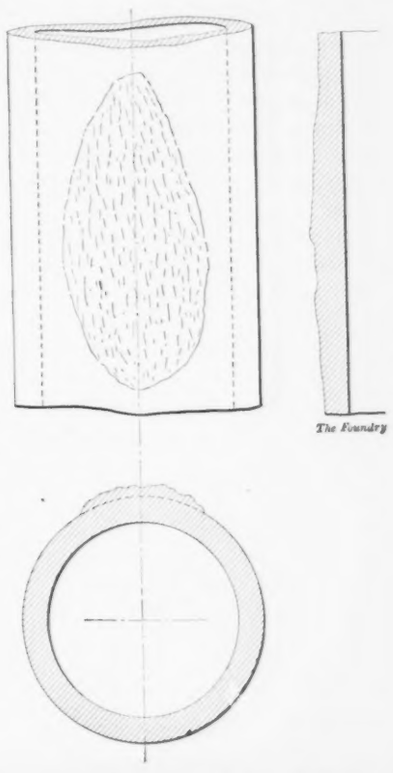
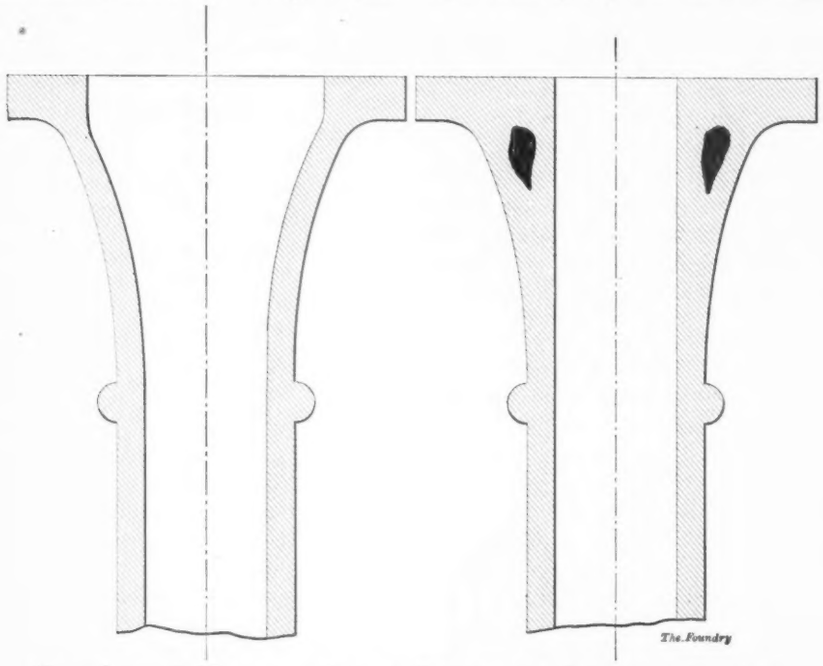


FIG. 4—CASTING BADLY SCABBED

mented to prevent the ingress of metal to the vents.

Venting Cores and Molds.

All the methods of venting of cores and molds, which are a study in themselves, have for their object the escape of air, or more properly the escape of the gases which are generated by the act of casting. And not only does the venting contribute to this result, but as already stated, the character of the sand used is an important element. Some sand is self-venting when used in small quantities, other kinds are so close that they require a very free use of the vent wire. The first named would be as unsuitable for heavy molds as the second would be for those of very small dimensions. Furthermore, the different locations of the sections of large molds exercise a considerable influence on the nature of the sand mixtures used. Those which are subject to great pressure, as the bottom areas, or to great strain, as tops of large area, should be rammed harder than other parts, and hard ramming entails the need of free venting, or scabbing will result.



FIGS. 5 AND 6—HEAD OF A COLUMN PROPERLY AND IMPROPERLY DESIGNED

The results of the confinement of gases in molds are nearly as varied as the causes which produce and retain gases. They vary from big blow holes, to a mere trace of sponginess, and they help to produce scabbing. They may occur in vital parts, so that the castings cannot be used, or they may be in comparatively unimportant locations. In some cases they are neutralized by getting them into the head metal or risers.

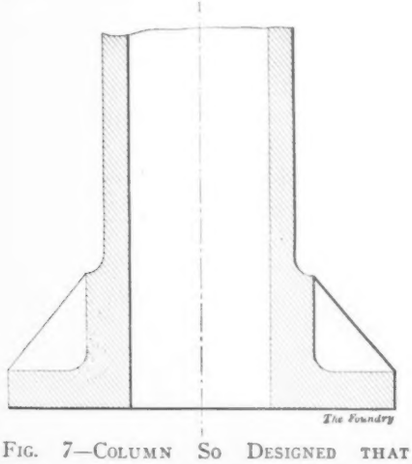


FIG. 7—COLUMN SO DESIGNED THAT SLIGHT DRAWING IS LIABLE TO OCCUR

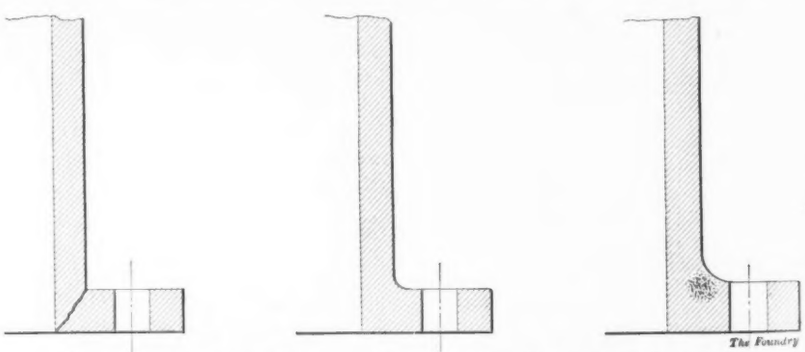
Blow Holes.

Fig. 1 illustrates a blow hole caused by the entanglement of a considerable body of air in the metal. Frequently there is no external indication of its presence. It may only reveal its existence upon tapping the casting all over with a hammer, or in the machine shop. If its presence is suspected, as when a casting is scabbed, or when the pouring was not quiet, the hammer test must be used. Any small holes may be probed with a wire, and a large blow hole may thus be located. Blow holes occur most frequently in the upper portions of castings; but they are found in all parts, wherever the air happens to be arrested by the metal.

The casting of wrought iron into castings is a fruitful source of blowing. Chaplets should be used with care and should be tinned. Wrought iron chaplets can be coated with gas tar to prevent blowing. They should be heated previous to insertion in the mold, and the casting should be poured before the iron has had time to cool.

Spongy Castings.

Sponginess or honeycombing is an open condition of the metal caused by the presence of air, dirt and non-homogeneous metal, occurring singly or in combination. It is not the same as a draw, though the appearances are somewhat similar. Honeycombing results from imperfect venting or the neglect of risers in some cases, insufficient skimming or poor metal. In any case, something takes the place of metal, though no large space may be vacant of metal, as in a blow hole. But the two may and often do occur in one and the same casting, and in proximity to each other. A blow hole may be termed a confluent honeycomb. Sponginess, like honeycombing, is more liable to occur in the upper part than in the lower portions of castings, and for this reason the parts of the casting to be machined are cast downwards, or if they must come in the top, are cleaned with risers. Fig. 2 shows the ap-



FIGS. 8, 9 AND 10—FLANGES PROPERLY AND IMPROPERLY DESIGNED

pearance of a badly honeycombed surface. Fig. 3 shows lugs in a similar condition, which could have been prevented by pouring them downwards, or by bringing a riser up over each.

A *scab*, Fig. 4, may be sometimes mistaken for a honeycomb, but there is no similarity between the two, beyond a roughened surface. A scab is metal in the wrong place. It is caused by the washing away of sand which has been rammed too hard, and insufficiently vented. The metal bubbles in the mold due to the presence of air which cannot get away, and the air breaks up the sand, and metal takes its place. The presence of the scab itself would matter little, because it might be chipped or ground off. But the evil is that the sand is buried somewhere in the casting, and it may not be possible to ascertain its whereabouts. Scabbed castings must therefore generally be classed as wasters.

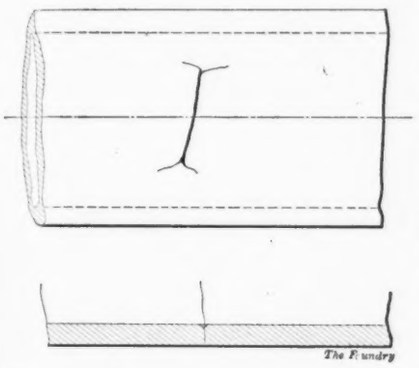


FIG. 13—ANOTHER DEFECT RESULTING FROM CASTING THE METAL TOO SLOWLY

Shrinkage.

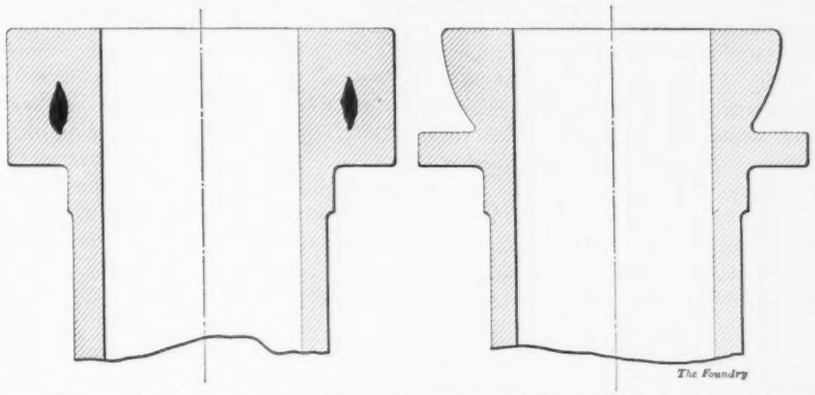
Draws are caused by the shrinkage of the metal in itself. Cooling, and setting first on the outer parts of the mold, it shrinks away from the interior, leaving a more or less open cavity—the draw. The crystallization is always larger about the central portions of a casting than elsewhere. A draw occurs when the crystals part company. The methods adopted to prevent this are good proportions, namely the avoidance of heavy masses of metal adjacent to lighter ones, and good feeding with fresh hot metal. Figs. 5 and 6 show a column head. Fig. 5 will not draw, but Fig. 6 will. The column shown in Fig. 7 is liable to draw slightly.

Pattern Design.

Bad design is a fruitful cause of waster castings, but much less in brass than in iron. Cast iron lacks the quality of accommodation to any large extent, hence when two very dissimilar sections are held in bondage to each other, the weaker yields in cooling. When both are free to yield, no harm results. Thus a piece 3 inches thick and one ½-inch thick, if adjacent, would suffer no stresses in cooling, because they are both free to shrink. But attempt to cast a heavy wheel rim and boss united with slender arms, or anything designed on similar lines, and fracture in cooling is inevitable. Hence, the broad and safe rule is to so proportion castings in iron and steel that all sections shall cool down *uniformly*, or at least within a very short period of each other.

But even here evil results may be, and frequently are neutralized by artificial cooling. Thick parts, as bosses, are uncovered and swabbed with water to hasten their cooling, while the thin parts are kept covered with sand to delay their cooling as long as possible. This cannot be considered desirable practice, but yet it is essential in many cases.

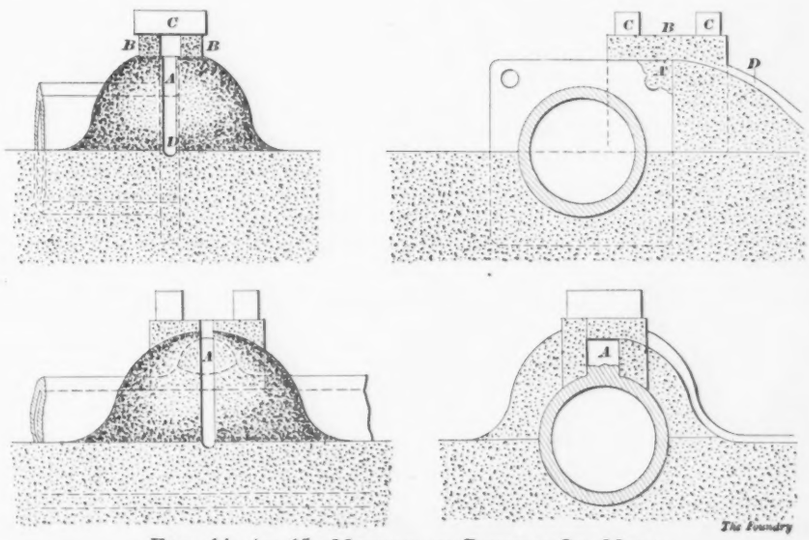
When the proportions of parts cannot be secured, there are ways of circumventing this difficulty so that the risks of fracture are largely minimized, or altogether eliminated. Chief among these is the splitting of bosses and heavy lugs. In a considerable degree the casting of large radii or brackets lessens risks of fracture, partly by insuring a better disposition of the crystallization and partly by the tie which they afford to adjacent parts. Thus the flange in Fig. 8 would invariably fracture, but Fig. 9, with a small radius, would not. Fig. 10 might develop a small amount of draw in the angle.



FIGS. 11 AND 12—IMPROPER AND PROPER AMOUNT OF HEAD METAL ADDED TO THE CASTING TO PREVENT DRAWING

Head Metal.

A valuable aid in counteracting risks of sponginess and draws in some kinds of work is the casting of head metal. It is in effect, a self-acting feeder head. To be effective it must retain hot metal as long as the



FIGS. 14 AND 15—METHODS OF BURNING-ON METAL

casting remains liquid, and have sufficient weight to feed the metal downward. A few inches in height generally suffices, but in some cases a couple of feet are added. The head is generally of the same diameter as the body of the work. If made as large as the flanges it defeats the object sought, by producing a draw, as in Fig. 11, some portion of which will come into the flange. An ideal head, preferable to the parallel form, is shown in Fig. 12. It is of the same diameter as the body of the casting at the place where it joins the flange, but is enlarged above to give a larger mass of metal which will retain its heat for feeding.

Another cause of bad castings lies in the nature of the metal used. The weaker a design, the greater reason is there why a soft grade of metal should be employed. Hard metal is more liable to fracture than a soft gray iron, while a medium mottled iron is preferable to either. Pouring metal too hot in some cases, and too dull in others, are evils to be avoided. Allowing metal to dribble slowly into a mold is liable to produce *cold shuts,* Fig. 13; pouring it too suddenly without flow-off gates is liable to result in the straining of large tops.

Repairing Bad Castings.

When the cost of a large waster casting is considerable, there are sometimes ways, more or less legitimate, of saving it. Burning-on of parts, the strength of which is not of importance, is sometimes practiced with some measure of success, though the metal in the locality becomes injured thereby. A better plan when practicable, as it often is, is to cut away the faulty part, and prepare a suitable separate casting, or a piece of forged steel or iron and bolt it in place. This can often be done with lugs, brackets, and flanges.

Examples of burning-on are given in Figs. 14 and 15, the former being the corner of a flange at A, and the latter a portion of a lug at A. In each case the portion to be burnt-on is enclosed with pieces of loam cake, B, B, Fig. 14, secured by ramming a large body of sand around them, and weights C C are laid on the top edges of the loam cakes. The metal is poured into the space left open, not usually through a runner cup, though that is sometimes used, depending on the job. A channel D is cut to carry away the surplus metal. The metal is poured very hot, and the pouring is continuous until the broken surface has been raised to the fusing point, when amalgamation takes place. Before this happens, 500 or 600 pounds of metal may have to be poured, and carried away by the channel D. The molder judges of the fusion by feeling the surface of the broken casting with the end of an iron bar.

Of the various causes of wasters here enumerated, all are more or less inexcusable. Some are very glaring, while others do happen in the experience of the most careful men. In arranging the molding of any new job, all contingencies should be considered, remembering that it is the unforeseen which usually happens.

WARPED OR DISTORTED CASTINGS---METHODS OF PREVENTION

BY JABEZ NALL

THE CAUSES leading to the warping or distortion of castings are so numerous and varied that it is difficult to establish a fixed rule for obviating this difficulty. Each job must be given individual treatment, and the success or failure of the work depends largely upon the experience and judgment of the foundryman. He may be able to guard against the warping of the casting, or be prepared to remedy it after it has taken place, as some castings cannot be prevented from warping and are frequently straightened by special treatment before they have cooled.

Variation in Daily Practice.

A molder working on an order of flat plates of a uniform metal thickness, will invariably claim that his practice is the same from day to day, notwithstanding the fact that a few of his castings were perfect and the remainder were consigned to the scrap pile. So far as he knows this may be true, but was his practice the same, and was it scientific and intelligent, or were the perfect castings mere accidents? Were the flasks bedded and clamped properly each day, and were they equally well prepared at the joints to prevent springing when clamped, thereby shutting off part of his mold and changing the lines of casting?

Was the sand of the same temper, and was it rammed evenly each day, or did the strain of the mold follow the lines of least resistance and affect the thickness of the metal in spots? Was the metal poured each day at the same temperature? Was the metal of the same analysis, and suitable for the work? All of these questions may enter into the causes of the warping of these and other castings.

Molding Flat Plates.

The law of cause and effect applies here as elsewhere, and given the time, means and opportunity, some interesting and valuable experiments could be carried on along the lines indicated. Trade, technical and other foundry schools please take notice and report results. The commercial or jobbing foundry would best make this plate in a good flask, an iron one preferred; the bottom board or plate should be level and solid, and the sand of an even temper, not too wet; the mold should be rammed evenly and vented freely, then poured from iron suitable for good machinery castings in an active fluid condition to fill the mold rapidly, and it should be left clamped until cold for the best results.

If shaken out, it is almost certain that the casting would be disturbed by the pulling on gates and risers when raising the cope, and if any air gets under the casting it will warp at the ends. This can be counteracted by leaving the ends covered with sand and stripping the plate across the center for about one-third of its length, and thus accelerate the cooling at this point. The under side of casting cooling later, it will then pull the ends down.

Care to Be Exercised.

While considering the causes of

the warping or distortion of plates, or other light patterns that are necessarily flexible in themselves, we will call attention to the necessity of care in getting these level and true, or at least in the desired position at the commencement of molding. In the case of thin plates when laid on a molding or follow board, it may be desirable to depress the center an amount that will vary with the size and thickness of the plate. When rolled over, this will show a convex surface on the face of plate, and if instead of molding from a follow board, it is desirable to bed the pattern in the drag, this would then, of course, be placed in the position as when rolled over in the first case. When the metal contracts, this would allow the outer edges to come up and may result in a straight casting that would otherwise be distorted; but when this is done it is important that the corners are not winding. Many castings are warped, not as a result of contraction, but of carelessness in the setting of the pattern in the first place. A good spirit level, and a true parallel straight edge (not any piece of board that is just sighted as true by the molder's eye) are the two best methods of prevention along this line. These are little things, nevertheless they are essential.

Plates of Varying Thicknesses.

Plate castings of the same outside dimensions, but of different thicknesses will act differently under identical conditions. If the plate has ½-inch or ¾-inch thickness we would expect it to curl upwards at the outer edges in all cases, but when 1½ inches thick, or more, we would expect the reverse. The reason for this is that the heat passes from the cope side of the mold more freely, and the top of the casting loses heat sufficient to commence contracting, while the metal in the under side is still soft, the contraction being somewhat retarded according to the amount of heat below. Naturally, this strain will tend to raise the outer edges, and in the case of a thin plate, this remains in that position because the strain of the contraction of the under side is not sufficient to reverse this, as it is when the plate is thicker, and there is a greater body of metal to contract. In the latter case, the casting is in a measure annealed by the greater body of heat, and this casting if thick enough would require stripping to again equalize the strain, and hold the casting straight. If this were done to the light casting it would aggravate the trouble to an extent that would ruin the casting. The thing to be done is to exert a pressure against this tendency to rise by leaving it covered and when set, to ram solid under the bars of the cope flask, particularly at the corners if the dimensions of the plate require it.

Clamping Flasks.

Another example of a distorted casting that came under my observation was a section about 8 feet 6 inches long, shown in Fig. 1. This, at first glance, appeared to be badly warped, particularly so for about two feet at one end, but a closer examination showed the top or cope side of the casting to be as near perfection as could be expected. What was it then that caused this sudden departure from the straight line on the drag side of casting? Investigation showed that the bottom board was weak, and had been left unsupported at this end. Probably soft ramming helped and when poured, the bottom of the mold strained downwards from the point of support. A run-out was only prevented by the flask which was large and there was a liberal supply of sand at this end. This sand compressed by the pressure of the metal, sufficient to prevent its parting. The result was an undesirable addition to the casting, shown by the dotted lines. The moral

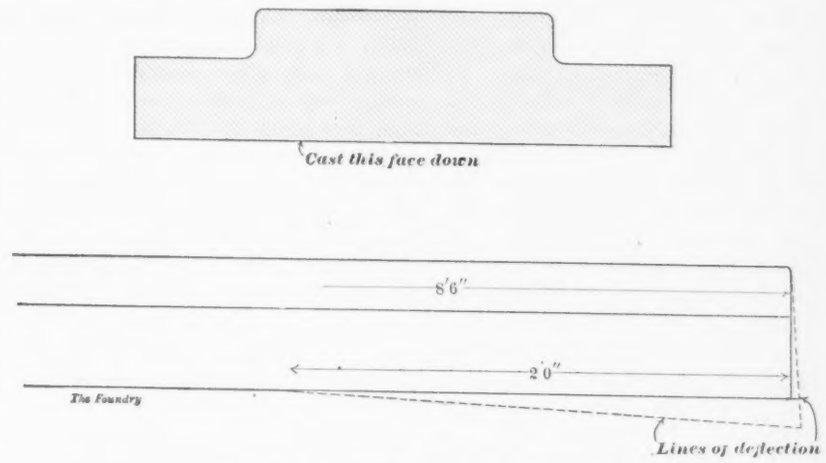


FIG. 1—LARGE CASTING BADLY WARPED

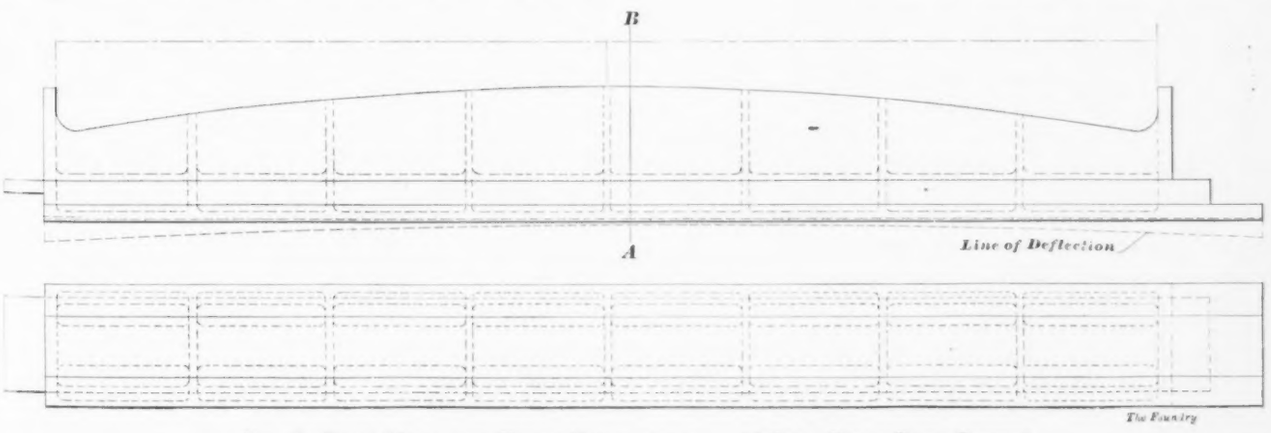


FIG. 2—PLAN VIEW AND FRONT ELEVATION OF A 14-FOOT CROSS RAIL CASTING

of this is, beware of improper clamping and bedding of flasks.

Large Cross Rail.

Fig. 2 shows a plan view and front elevation of a 14-foot cross rail, and Fig. 3 an enlarged cross section on line A, B, Fig. 2. The broken lines indicate the lines of core prints and cores, the latter being made half length. It is molded on edge as shown in the sectional view. It will be noted that the metal along the face C, Fig. 3, will average about 3½ times the thickness of metal in the supporting ribs, according to the theory of contraction as set down in the preceding article. These ribs cooling first have already contracted as much as possible, the contraction being somewhat resisted and limited in amount by the slower cooling of the heavier section of metal and this, if left to cool slowly, will pull the ends of the casting around, until they are deflected fully ¾ inch from the straight line as shown in exaggerated form in Fig. 2. These castings are usually bedded in the foundry floor, and when cast the cope is removed, sand left covered over the ribs, and when sufficiently set so that there is no danger of bleeding the casting, the face is stripped all the way down to the lower edge, for fully two-thirds of the length, and in some cases, where the disproportion of metal is greater, for the entire length.

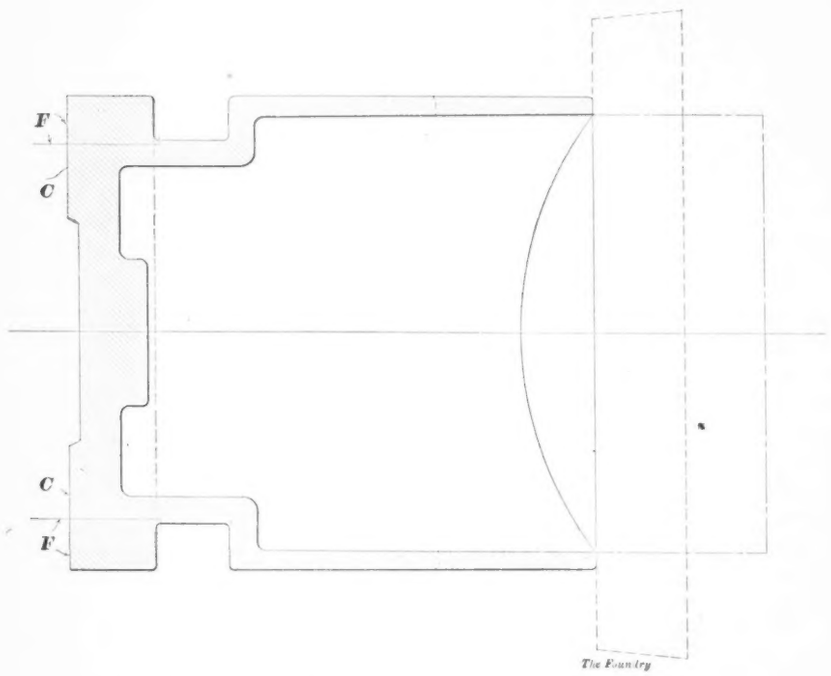


FIG. 3—ENLARGED CROSS SECTION ON THE LINE A, B, FIG. 2

Accelerated Cooling.

Thus, by accelerated cooling, causing the contraction of the heavier section of metal to keep pace with that of the lighter section, which has been retarded as much as possible, the warping of the casting is prevented. If this is successfully done, the result will be a straight casting; but if it should vary a little from the straight line when examined the following morning, if taken out of the sand and properly placed on blocks, it can be straightened or adjusted by its own weight, if not yet cold. If the stripping be done at the right time, and in the right way, this will not be necessary. Notwithstanding the success of this method, it seems to me that the extra work and risk could be avoided by bending the pattern the required amount in the opposite direction, the casting being left to cool slowly without being exposed. This would do away with the risk of the face being hardened too much by rapid cooling to permit it to be machined successfully. A hard casting will add materially to the cost of machine work.

Another Method.

Another method by which a clean face on this casting could be secured would be by molding the face down by making the pieces at F, Fig. 3, loose on the pattern, and making an overhanging print, as shown in dotted lines, so that it would not be necessary to use chaplets to support the cores. This method may be still more applicable to other castings of a disproportionate section that it is desirable to cast face down, which makes accelerated cooling impossible as the parts requiring it would be inaccessible. In other cases, where the shape of the casting is such that it gives no choice in the manner of molding, this, or a similar method is imperative, and either the pattern must be bent, if it is rigid in construction, or if flexible or in part lengths, the face of the mold must be given a sufficient camber to adjust the strain of contraction. An example of this will be shown later.

The theories as well as the practice indicated in this article will not be new to the experienced molder, who has doubtless had more difficult propositions and mastered them, but to borrow a phrase, "there are others." But even when the experienced molder has put forth his best efforts along the lines that he has found successful scores of times, he may be surprised at his failures, and the warped or distorted casting that is the result of his labors may not be his fault. Among the preventatives of warped castings, the most effective is the right kind of iron.

POROUS GRAY IRON CASTINGS.

By W. J. KEEP

Question:—We are experiencing considerable trouble with porous castings which are soft enough to be machined and do not develop hard spots. The iron is used sufficiently hot and the runners are clean, yet the castings poured from a 1,200-pound ladle will vary to a large extent. A few may be perfect but the others will develop blow holes when they are being machined. We are using 28 per cent of car wheel scrap and 22 per cent of No. 1 soft pig iron.

Answer:—Use 40 per cent of No. 1 pig iron and 40 pounds of limestone to each ton of iron which should be charged on the coke. Melt the iron very hot and get it into the molds quickly. It is also essential that your coke be analyzed inasmuch as it is evident that your troubles are due to too high a percentage of sulphur. Your car wheels undoubtedly contain about 0.10 per cent of sulphur and the coke should, therefore, not contain more than 0.75 per cent of this element. Limestone free from pyrites, and hot melting will drive off the sulphur.

THE USE OF STRICKLES AND SWEEPS

A brief summary of the advantages of these tools in the foundry for making molds and cores

BY JAMES F. BUCHANAN

STRICKLES and sweeps are nowadays regarded as two distinct classes of tools, the strickle being any templet worked along a guideway, and the sweep being any profiled board or segment, revolved from a center to form the required design in the mold. Of all the appliances employed for getting out castings in jobbing or general foundry practice, the strickle is probably the oldest and the simplest.

Much of our modern foundry and pattern shop practice assumes that the

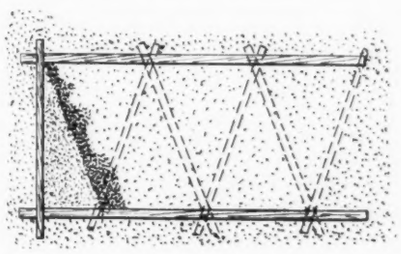


FIG. 1—STRICKLE USED FOR LEVELING AN OPEN SAND BED

strickle is a back number, an obsolete contrivance, a lumbersome, time-consuming device, designed, no doubt, by some parsimonious patternmaker to disprove the "necessary evil" idea usually associated with the prodigality of wood and wood craft in foundry work. A more sensible view would be to acknowledge that the strickle has its place, and in its place—the jobbing foundry or wherever work of liberal design is done—its proper use affords great scope for the display of skill, ingenuity and accuracy in the molder, giving him a sure means of obtaining by his own unaided efforts, sound true castings that show individuality.

Bolland wrote: "In skillful hands the strickle affords an excellent opportunity for the display of high class molding." To that, other testimony might be added, proving strickling to be the basis of what might be termed the higher education in the art of molding. Many live foundrymen are so much engrossed in the reproductive capacity of mechanical inventions that they have no time to look into the things that really are essentials in molding. Strickling is one of those. It deals fundamentally with form and the development of design and it lends itself to a broad style, inculcating careful work and demanding greater manual dexterity than most of the ordinary processes.

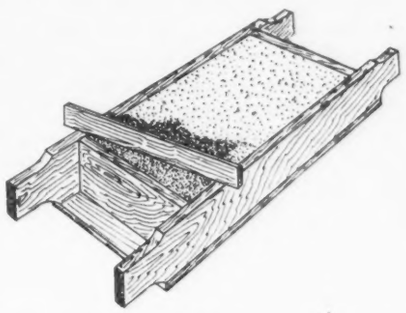


FIG. 2—STRICKLE USED FOR STRIKING OFF A RAMMED FLASK

Elementary Use of the Strickle.

Concerning the practical uses of the strickle, we are all familiar with its most elementary application in making an open sand bed or in leveling the sand off a rammed flask, shown in Figs. 1 and 2. This appears to be such a simple operation we are scarcely prepared to admit a wrong use

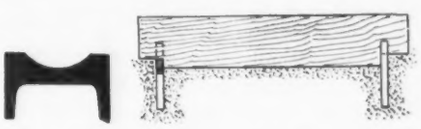


FIG. 3—STRICKLE USED IN PIPE WORK

of the strike as possible. And yet, the beginner invariably essays to shave off the surplus material by one long, strong, straightforward, comprehensive pull, rather than by the gently progressive, catty-cornered series of strokes adopted by the experienced artisan. This demonstrates very forcibly that there is a right and a wrong use of the strickle. Its primitive use was that of a straight edge for striking mobile or plastic materials to a level, as grain in measure, or sand in a bed.

In the early history of founding, the strickle or former was a most important tool. Long before patternmaking evolved, or the multiple mold was thought of, it had a vogue and a career of usefulness to its credit. In fact, the evolution of the art of patternmaking may be traced to the early molder's free use of strickles, straight edges, sweeps, segments and skeletons. The patternmaker who can devise and the molder who can manipulate these practical aids has

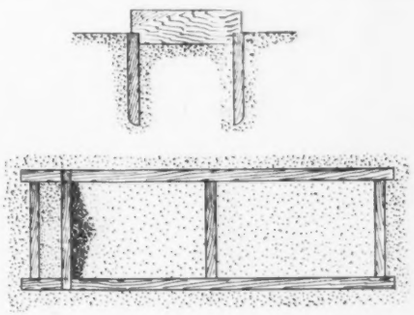


FIG. 4—STRICKLE USED FOR MOLDING SHEATHING PLATES

a grip of all that pertains to the larger elements in foundry practice.

Typical Examples.

Some typical examples of the use of strickles are shown in the accompanying illustrations, also various devices for sweeps. It should not be necessary here to describe the making of the molds from these templets and strickles in detail, but it would form a good exercise for the student of foundry work to follow various processes involved. Naturally, the sand molder will want to use the strickles on sand and the loam molder will adapt them to various materials according to the nature of the job. It is not an unusual occurrence for a

mold to be made by a combination of methods, sand ramming and loam strickling being both essential. An example of this kind is illustrated in Fig. 13, where the board is set for sweeping the pattern of a large pump

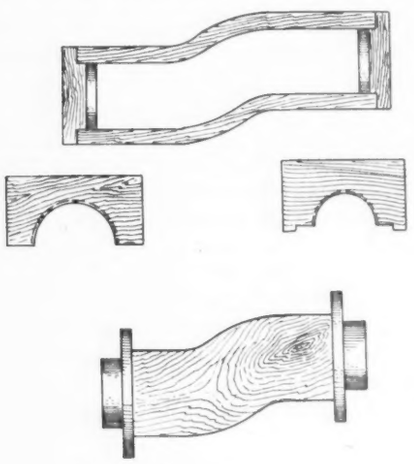


FIG. 5—SKELETON PATTERN

body in loam. Several brackets, bosses and ribs are then fastened on in definite positions by the patternmaker to complete the design and the mold is rammed with sand the same as if a wooden pattern had been built.

Economies Effected.

After the outside of the mold has been rammed and parted, the core is laid bare by stripping off the pattern thickness. The economy of patternmaking in a job of this description is very great indeed and the molding expense should not exceed the ordinary cost of molding with an all-wood pattern.

In bedding in work on the floor

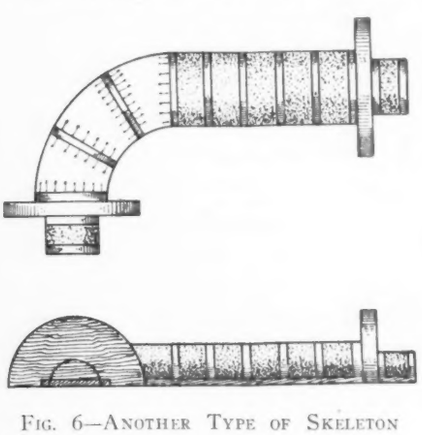


FIG. 6—ANOTHER TYPE OF SKELETON PATTERN

strickling is sometimes resorted to as a means of getting an even layer of sand on which to knock down a pattern. Fig. 3 shows one way of getting a regular mold surface in pipe work. The bed is rammed up to the floor level with the cast iron guides set at the proper distance for the length of pipe. The floor sand is then dug out between the guides and about 2 inches of facing sand is strickled, without previous ramming, to the contour of the pattern. By knocking down the pattern on this even surface of loose facing sand, a perfect mold bottom, with neither soft nor hard places, results. This idea can be applied to various shapes of patterns and the guides may be cast in an open sand bed. Of course, in pipe work, only odd sizes and specials are recommended to be made with strickles.

Skeleton Patterns.

For occasional castings the skeleton pattern commends itself. Figs. 5 and 6 illustrate two different styles, but for a regular trade, a complete well built pattern, with substantial rapping plates fitted, is the most economical. Fig. 4 shows some sheathing plates used for covering the propeller aperture frame of a ship. These plates are cast in zinc to prevent corrosion of the steel or iron framework by the galvanic action of brass or bronze propeller wheels. This is an example of the convenience of the strickle. The molding of these plates can be much better and more economically done by this method than by the use of a solid pattern and core box. The two sides are set in position on a level bed, stay pieces being inserted between them to prevent ramming-in. The outside and inside being rammed up to the floor level, the cope is filled in and rammed, and then the strickle comes into operation to remove the ¾-inch thickness which forms the back of the sheath, after which the two sides are drawn.

Sweep Boards.

The sweep is simply a revolving strickle. The peculiar importance of the sweep centers in the fact that although a mere outline of the proposed mold or casting is provided, the perfect form may be developed by its use, and not a molder among molders but recognize its educational value in planning and executing sizable symmetrical foundry work. For producing castings of size and symmetry the sweep is an ideal instrument, but its practical and economical possibilities are not always realized in foundries. Because it is an ancient device, demanding higher skill in the artisan, we are apt to overlook its advantages. The chief reason for introducing strickles and sweeps in foundry work is economy. Generally it is to save expense in the patternmaking department by obviating the need for the construction of a complete model or pattern. Sometimes there are also economical points in the actual molding work, particularly on casual or bulky jobs. True economy, however, is a combination of the simplest, the cheapest and the best, and in molding large symmetrical castings with sweeps, the two last considerations carry most weight. Some one has very aptly defined the patternmaker as a molder's toolmaker. The sweep is

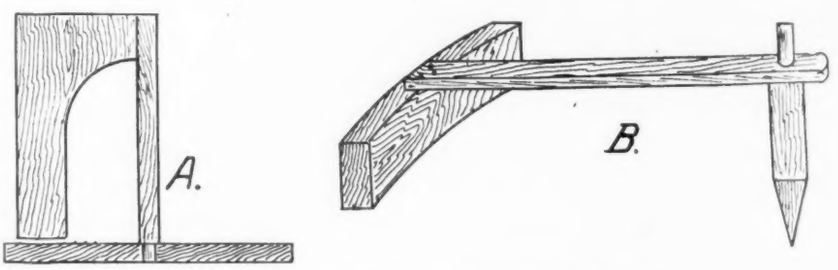


FIG. 7—PIN BOARD AND SEGMENTAL SWEEPS

one of the best tools he makes and it must always be regarded as an arbitrary tool.

Variations in setting the sweep boards are not permissible, as for every divergence the penalty must be paid in a wrong size. For this reason some patternmakers make all sweep boards fit hard up against the spindle to be used, as at X, Fig. 12, so that it is impossible to make any error. The general practice, however, is to leave a clearance and provide gage sticks which regulate the distance from the center of the spindle to a stop on the sweep board as at S, Fig. 12. This allows the molder more latitude in working the board, avoids differences due to the shrinking or swelling of the wood, and does not make an absolutely parallel spindle imperative, as would be the case with the fixed radius board.

Sweeping Cores.

The pin board sweep is probably the simplest form of sweep that can

be made. This is used chiefly for cores which depart but slightly from the cylindrical form, as in the dome shaped core board shown at A, Fig. 7. In Fig. 10 we have another style of board which is used for running up loam cores on an iron barrel. In this example there is a reversal of the ordinary use of sweeps. The work revolves and the strickle or sweep remains stationary upon the trestles or core lathe. A good deal of pattern work is done in this way by striking a thickness upon the core after it has been dried and blackwashed. Quite a number of molds can be made from a loam pattern of this kind if the finished thickness is brushed over with a thin solution of plaster of Paris. The latter is superior to tar as a parting medium and lines show up better on the white surface.

A loam core is usually made by winding on hay rope to within a certain distance of the finished diameter. Fig. 8 shows a method of increasing the diameter of a core barrel to save the hay band. This method is very

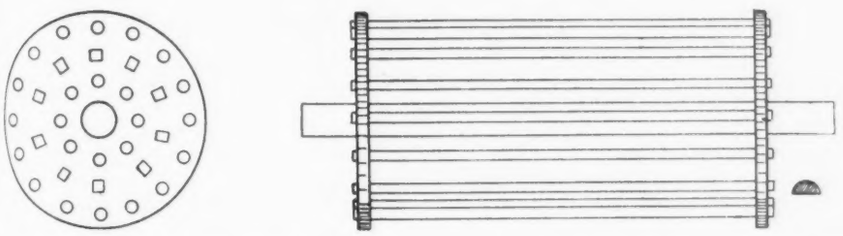


FIG. 8—METHOD OF INCREASING THE DIAMETER OF A CORE BARREL TO SAVE HAY ROPE

convenient for cores having small outlets on the ends, as is the case with plungers, drums, air vessels, etc. Sometimes the sweep takes the form of a segment. The piston ring segment sweep is about the most elementary example we can find in this class.

Segmental Sweep.

At B, Fig. 7, is shown the segmental sweep, which is used with sand only and to turn out good work with it, it is necessary to have a proper center from which the board can be worked freely to describe a true circle.

Fig. 14 illustrates a device which is often used for segmental work when the pattern design is undercut, or prevents the vertical lifting of the segment when the sections are rammed. Helical wheels, grooved pulleys, double flanged rings, and many other castings, may be cheaply made by fixing a short segment to this hinged radius bar. As each section is rammed the thumbscrew is undone to allow the part pattern to draw inwards. The inside parts of molds in this class are usually made in cores.

Use of a Stool.

Fig. 9 illustrates a convenient form of stool for sweeping shallow designs in an ordinary molding flask, or on a plate. The flask or plate can be lifted away, after the roughing coat, to be dried in the stove. It may then be landed on the stool and set for finishing, thus avoiding one objection to much of the loam molder's work, namely, that it should be made, dried and cast without being moved. Fig. 11 shows an example in section, well suited for making by this method. The full set of sweep boards enables the molder to get out this casting quite as cheaply as with a pattern. Sometimes the bottom flange in jobs of this class is made in cores which are let into a print swept up with the cope, but a better plan is to produce the flange on the bearing, as at F, board A. This sweeps up a pattern of the flange in sand which can be removed like an ordinary sand thickness and there is no trouble fitting cores or ugly joints on the casting where the core segments would meet.

Storing Strickles and Sweeps.

In jobbing foundries, pattern storage, owing to the miscellaneous nature of the work, is always a difficult problem. Strickles and sweeps lend themselves to convenient methods of storage which require the minimum of space. Fig. 15 shows how the boards and loose pieces, if any, connected with the job, are all fastened together and can be hung upon rods projecting from the walls of the building. If the boards are expected to be used very frequently the striking edge is generally faced with sheet iron. Loam molders aim to keep a good edge on the board by using the sharp edge for roughing up and the beveled edge for finishing. Skinning loam on to a hot mold or core partially made, soon blunts the edge. The remedy under these conditions is to use thin, fine loam and to get round the work as quickly as possible. The small amount of surface exposed to wear at the beveled edge of a sweep board is certainly in its favor, but it should be remembered, the abuse of the board affects the mold all around,

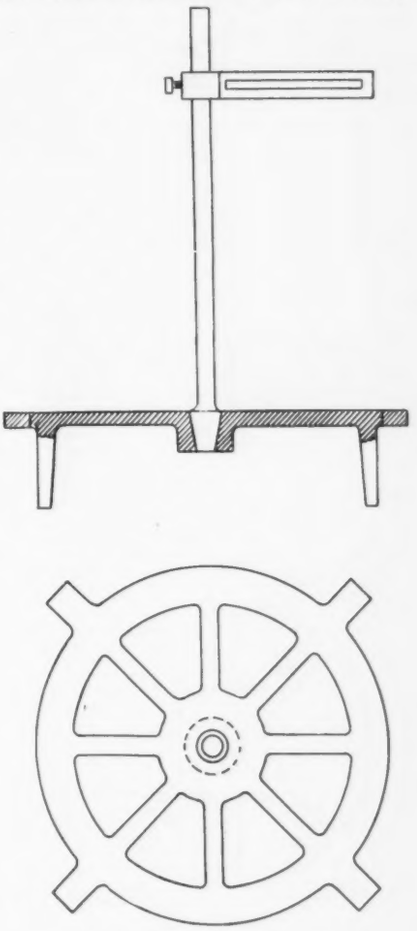


FIG. 9—STOOL FOR SWEEPING SHALLOW DESIGNS IN AN ORDINARY FLASK OR ON A PLATE

whereas, hammering a pattern produces only a local blemish.

Loam Molder's Horse.

In Fig. 13 the wall bracket spindle

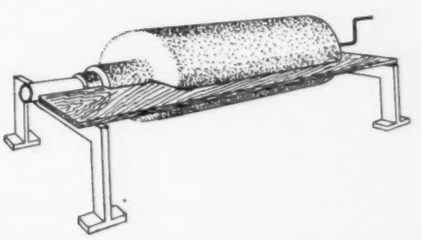


FIG. 10—BOARD USED FOR MAKING LOAM CORES ON AN IRON BARREL

bearing is seen to advantage. This device is sometimes called the "loam molder's horse." It is used chiefly for long cylindrical shapes. If used in conjunction with the stool, Fig. 9, any number of molds can be swept

in loam without re-setting the boards. Separate spindles for core and cope boards would be necessary, but when the parts are built they can be finished, dried and cast in any convenient

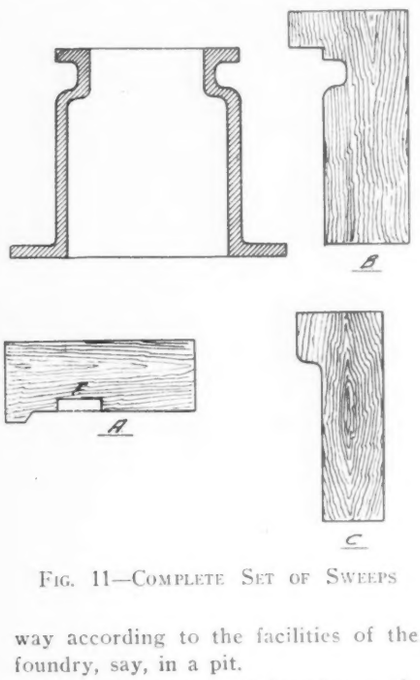


FIG. 11—COMPLETE SET OF SWEEPS

way according to the facilities of the foundry, say, in a pit.

As an illustration of foundry work, the propeller wheel is a somewhat hackneyed piece, especially in technical schools. Fig. 16 is interesting, chiefly because the propeller shown has differential pitches, the blades having a different angle at the root from the pitch angle at the tip. To build the bed for the face of each blade, two seatings are swept on which the separate gables rest. Otherwise, the mold is made exactly as for any ordinary propeller wheel.

Conclusions.

Concluding this article, enough has been said to show that strickles and sweeps comprise an important branch of molding practice. The good molder should have a working knowledge of the three S's,—strickles, sweeps and skeletons,—as well as the three R's. In a foundry deprived of strickles or sweeps, only the petty, monotonous reproductions and the good machines, survive and multiply. The good molders die off. It is resolved, therefore, that strickles and sweeps deserve honorable mention for long service in the foundry; that a knowledge of their use constitutes the ground work of a good education in molding practice, and that a record of their proved advantages and economy be continued for the future training of recruits in the art of molding. Strickles and sweeps are for serious work.

I know of no way of grasping the definite beauty of molding principles better than to traverse the road with the loam molder and his "horse." A summer morning, an interesting job, a clean sweep running like a bird, make a happy combination for the good molder. He feels there is "joy

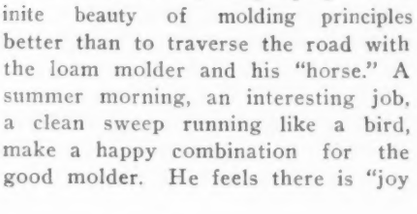


FIG. 12—METHOD OF FITTING THE SWEEP BOARD TO THE SPINDLE

in work," and if he is musical will strike up a refrain in keeping with his task on hand.

"I laugh and chuckle, Ho! Ho!
As I work the strickle below.
Oh, the spindle and board
Are the loam-molder's hoard.
Give the straight edge and level a show."

Science may go on flourishing in the foundry, but art will never die there while we retain the loam molder and his "horse," or the patternmaker who understands the limitations of the sweep and the poetry of a well made print.

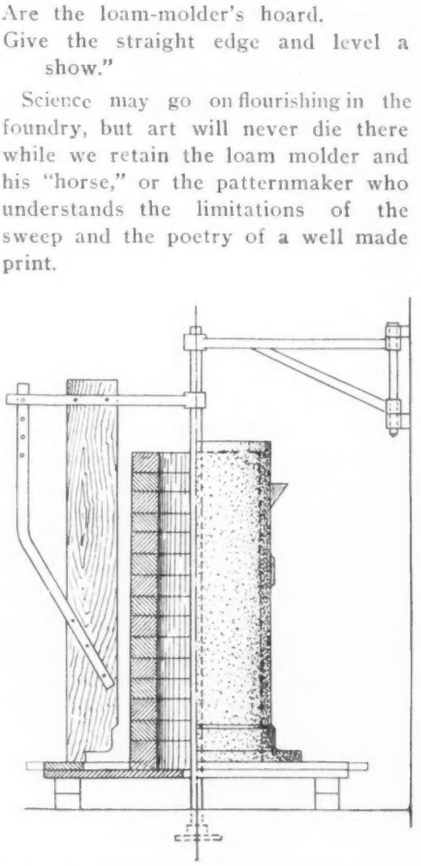


FIG. 13—METHOD OF SWEEPING A LARGE PUMP BODY IN LOAM

BRITISH FOUNDRYMEN'S ASSOCIATION.

R. Buchanan is well known to American foundrymen as the founder of the British Foundrymen's Association, and one of the most capable members of the craft in Great Britain. Though he has retired from the national chair he is still president of the Birmingham branch, and on Oct. 24 delivered his presidential address to the local foundrymen.

The speaker said that the foundrymen's association owed its origin to the belief that British workers were not moving along the lines of advance open to them. While he held that British operative foundrymen were second to none in the world, they had much to learn. There was no finality in the study, and self-satisfaction was the measure of ignorance and not of knowledge. Very often the most far-reaching results resulted from the discovery of facts supposed to be trifling. But imagination was essentially necessary because without it science could not be applied to practical work. All practical work was done through the application of science, although they might not recognize or even know the laws governing their methods and materials. They could not do good practical work if they transgressed scientific law. They must equally avoid the belittling of science and the satisfaction with old methods on the one hand, and on the other, the child-like acceptance of what claimed to be scientific. Criticism founded on ignorance was better than a blind ac-

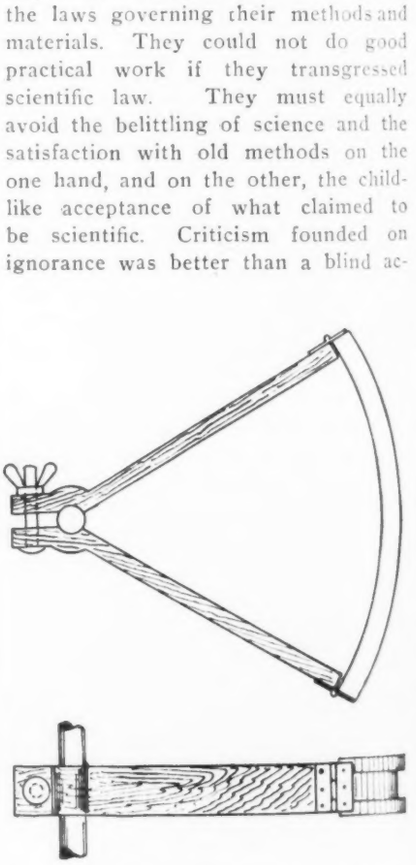


FIG. 14—DEVICE FREQUENTLY USED FOR SEGMENTAL WORK.

ceptance of what might or might not be a scientific fact.

The speaker quoted Hugh Miller to the effect that while the careless incompetent scholar had many opportunities of recovering himself, the equally unsatisfactory apprentice who was discharged as an inferior workman was usually unable to make up for his deficiencies and so fell out of regular employment.

Dealing next with scientific institutions, Mr. Buchanan suggested that the National Physical Laboratory should help iron founding and other industries by investigating the conditions under which liquid contraction takes place. The annual loss from that cause could not be less than £250,000, but they would need the co-operation of the metallurgist and the foundryman. The commercial conditions of the foundry prevent investigation, but the founders would certainly co-operate and furnish ample opportunities.

Statistics were quoted on the question of wood exhaustion to the effect that in 30 years there would be a time of great scarcity when the United States supply would be exhausted. This pointed to the more extensive use of steel and iron in buildings, and would affect patternmakers very considerably.

A short discussion followed. A. H. Hiorns strongly supported the idea of a central laboratory in such places as Birmingham, where hundreds of small works unable to support a chemist could send their goods and so solve their problems.

Mr. Buchanan repeated his belief that the question of liquid contraction could not be solved except by persons of high scientific attainments acting in conjunction with some one in possession of a good foundry.

MIXING HIGH AND LOW PHOSPHORUS IRONS.

By W. J. Keep

Question:—Is it practical to mix pig irons of various grades in which the phosphorus contents are extremely high and very low? For example, one brand of iron would analyze silicon, 1.50 to 2.25 per cent and phosphorus 0.20 to 0.30 per cent, while the other might contain silicon 2.75 to 3.25 per cent, and phosphorus 1.30 to 1.50 per cent. It is contended that on account of the two irons having different specific gravities, and owing to the difference in the melting points, that they will not mix properly in the cupola, and that after being melted one will float above the other.

Answer:—This condition would apply only to bodies like oil and water which have no chemical affinity for each other. Iron will absorb silicon, carbon, sulphur and phosphorus. These elements are all lighter than iron and after being chemically combined none of them will float unless more is added than the iron can absorb. In melting in a cupola, the irons which are hardest to melt should be charged underneath those with the lighter melting points. However, the melting points of different grades of iron are so nearly the same that with ordinary charging all will reach the tap hole at practically the same time. The instant that the two molten irons unite, they form a uniform mixture; for example, silicon 2 per cent and phosphorus 0.20 per cent + silicon 3.0 per cent and phosphorus 1.50 per cent = silicon 2.50 per cent and phosphorus 0.85 per cent.

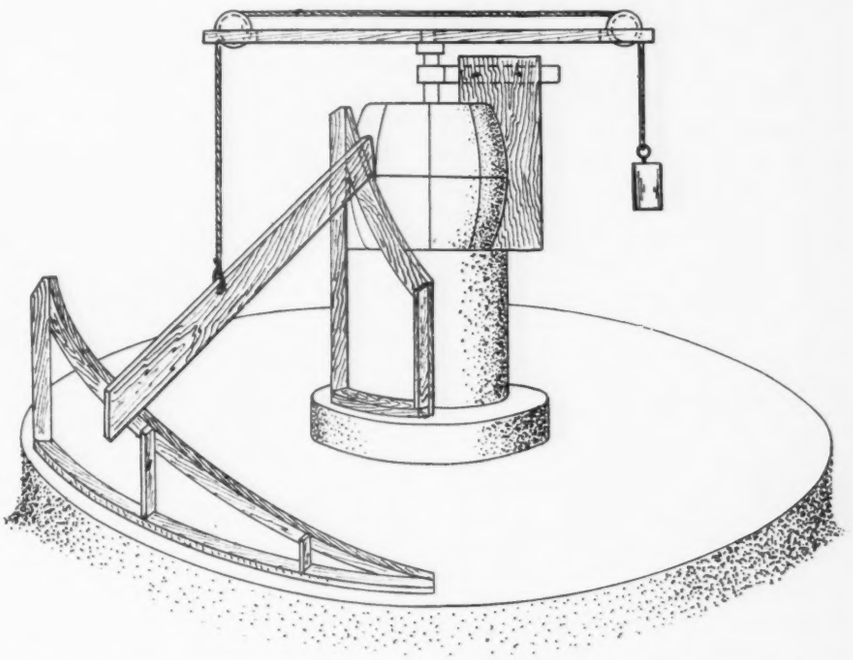


Fig. 16—Sweep for Building the Bed for the Faces of Propeller Blades

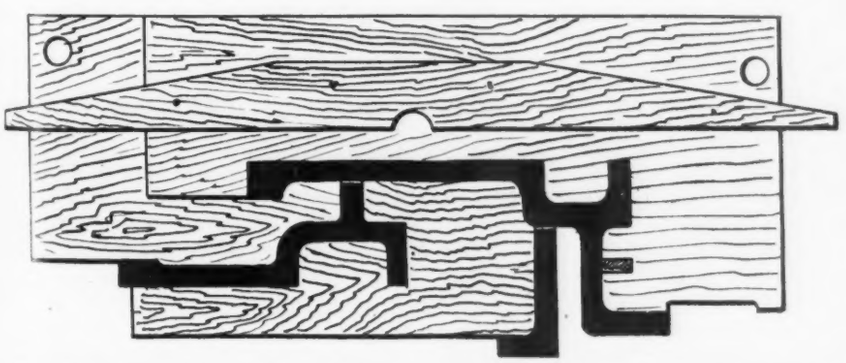


Fig. 15—Strickles and Sweeps Fastened Together in the Pattern Storage

SOME KINKS IN PATTERNMAKING.

By John B. Sperry

IN THE following article I will outline my method of making reducer elbow patterns of small and medium sizes. These sizes should be made solid, as they are cheaper, easier made and stronger. Fig. 1 shows the general construction of the pattern. It is made in halves and each half consists of three parts, A, B, C, held together by screws b, b, b, etc. The ends C and B are turned in the lathe, but the body A is worked out by hand in the following manner. Glue up enough stock to make the body in halves and plane the broad face of the blocks parallel. On one of these

faces of each block lay out the body of the elbow A, as shown in Fig. 1, and saw out on the band saw. Square ends a a, then work the sides of the block down to the outline of the elbow, keeping them perpendicular to

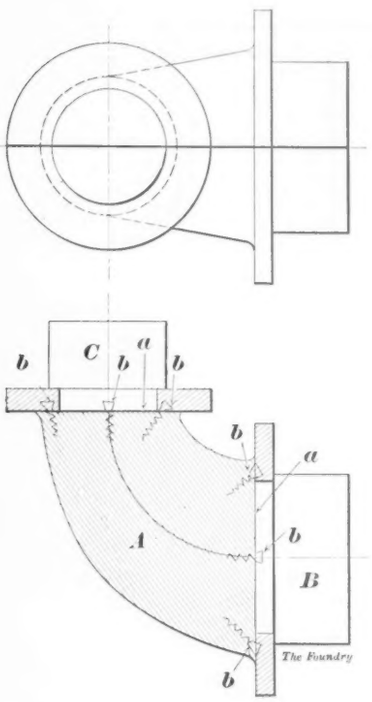


FIG. 1—REDUCER ELBOW PATTERN

the parting face. On each end lay out the diameter of the pattern for that end and with a protractor square set at 45 degrees mark off lines C tangent to the circumference, and with a heavy paper straight edge connect the corners of each end by lines as shown in Fig. 2 at e.

Then plane the taper of the reducer on the side opposite the parting face and with the draw knife form the blocks into an octagon elbow, being guided by lines c and e and the protractor square set at 45 degrees. There will then be eight points at any section and the rest of the shaping will be easy.

Do not glue ends C and B to A, but screw them together, because it is often necessary to insert a piece between for special work. In making the core box, the simplest way, I find, is to gouge it out to about the right size, and test for roundness with a wooden right angle triangle. A wooden triangle is better than the try square, since it does not cut down into the edge of the core box.

There is hardly a patternmaker who has not used leather fillet. Accompanying each bundle of fillet there is usually a card of instructions saying that plenty of good glue should be used. I have found that thick yellow shellac gives better results, with the additional advantage of being water proof. To put on the fillet I use a horn as shown in Fig. 3. This horn is made of hard wood and shellaced. The part C is made with a varying radius so that it will fit different size fillet. To use it, give the part of the pattern where the fillet is to go and the leather fillet, a coat of thick yellow shellac. Allow it to soak in a little and then give it another coat. Put the fillet in place and tack one end. Then with the horn press the fillet in place by rubbing away from the fastened end. Fillets put on in this manner present an excellent appearance and will not loosen by water soaking in the sand.

Straightening a Warped Pattern.

Taking the warp out of a pattern is generally a mean job. This is the way a centrifugal pump shell pattern was straightened in a neat way. The pattern was for the solid volute type of pump and was warped so that it curled away from the parting face. A stick 3 x 4 inches, long enough to stretch across the pattern and project on either side about 1 inch was planed, tapering from its center to the ends, so that the ends were 3/64

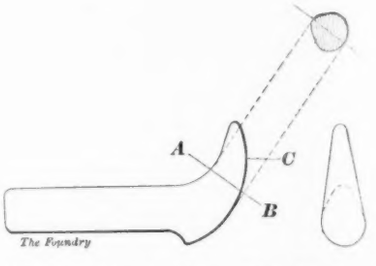


FIG. 3—HORN USED FOR APPLYING LEATHER FILLET TO PATTERNS

inch narrower than the middle. The pattern was then sawed three-fourths through with the rip saw, as shown at Fig. 4, at points marked a, a, a. Then it was clamped to the stick, as shown. This opened up the saw slits. Wooden wedges were fitted into

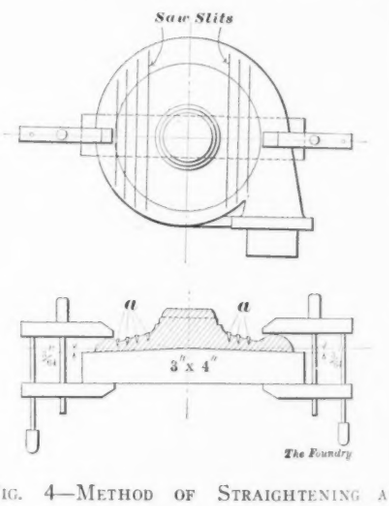


FIG. 4—METHOD OF STRAIGHTENING A CENTRIFUGAL PUMP SHELL PATTERN

these slits and glued, and after setting for 12 hours the clamps were removed and the pieces set in were worked down even with the pattern. The other half was fixed in the same manner.

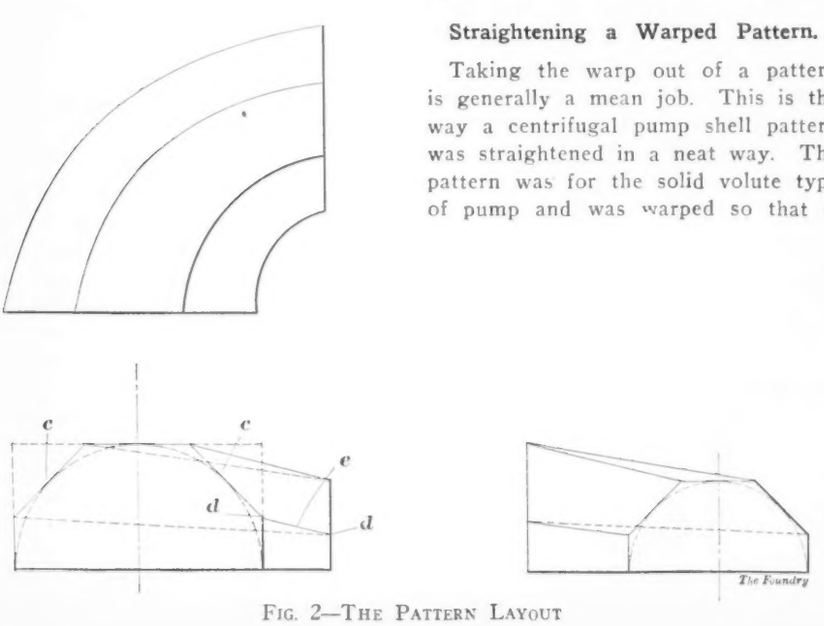


FIG. 2—THE PATTERN LAYOUT

BOTTOM DROPPED THE LAST TIME.

The foundry of Isaiah Page's Sons, Albany, N. Y., was permanently shut down Oct. 15, and is to be sold or dismantled. It was established in 1826 by Isaiah Page, grandfather of the present owner, Charles M. Page, at Chatham, Columbia county, N. Y. In 1855 it was moved from Chatham to Albany and has remained in its present quarters for 58 years.

THE PURCHASE OF PATTERN LUMBER

Suggestions for effecting economies in the purchase and care of raw material for the pattern shop

BY OSCAR E. PERRIGO

IN ALL manufacturing operations of the present day there is a more constant consideration of the question of economy in expenses of all kinds, and particularly of those relating to the purchase, care and use of material than has been the case in recent years. Sharp competition has so reduced net profits that economy has been an enforced condition that must be considered at every stage from the purchase of the raw material to the shipment of the finished product. The spirit of economic administration which has entered into the management of manufacturing enterprises in so thorough a manner as to extend to all the details, seeks all legitimate methods of decreasing the expense of manufacturing operations, without losing any of the essential qualities of efficiency and accuracy.

While these efforts are noticeable in the manufacturing departments where much of the material purchased enters directly into the product, there usually seems to be a special effort made toward economy in the purchase of material and supplies for the pattern shop. Perhaps the reason for this is that in many concerns the pattern shop is considered a necessary evil, something to be tolerated rather than fostered. With this view of the subject as the inspiring motive, the pattern shop has frequently suffered from periodical attacks of supposed economy on the part of a well meaning manager. Such policies only tend to discourage and confuse the men who are generally intelligent, loyal and competent, and who, to a great extent have the real good and progress of the concern at heart.

Usually there is not a great variety of wood used for patterns. In many shops there are but white pine and cherry, with occasionally, perhaps, a small pattern for which a piece of mahogany is obtained. White pine has been long the favorite material of the patternmaker and its fitness is unquestioned, particularly by the men themselves. The ease with which it is worked, the smoothness of its finish, its admirable qualities of taking glue and shellac, and in its properly seasoned state, its reliability and absence of tendencies toward warping and distortion are quite sufficient reasons for the patternmakers' good opinion.

Good authorities on patternmaking have for years contended that of the softer woods pine is the only reliable one suited to pattern work. One prominent authority says that "for the general line of pattern work there is probably no better material to be found than white pine." In recent years, however, the scarcity and high price of white pine of a sufficiently high grade for good pattern work has induced progressive men to try other kinds of wood for this purpose.

Poplar or Whitewood.

In this connection it is hardly a question of finding a better pattern lumber than white pine, but rather one of finding a suitable and satisfactory substitute at a lower cost. Nine different woods are considered suitable for pattern work, viz., pine, cherry, mahogany, red cedar, butternut, whitewood, birch, maple and black walnut. As a rival to pine for large patterns or general pattern work requiring a considerable amount of lumber, whitewood, or as sometimes called, yellow poplar comes first and butternut second. There is a feeling among patternmakers that whitewood is not a very safe material for making patterns. This feeling is partly due to the fact that it is not yet in general use for such purposes, and partly to the fact that there is a confusing variety of whitewood or poplar in the market. While the true yellow poplar, properly cut from the log and thoroughly seasoned is quite as free from the danger of warping as white pine, there are varieties of white poplar, frequently called West Virginia whitewood, the boards cut from which would, in the language of one old-time patternmaker, "make good shingles for a whirlwind."

A good quality of yellow poplar works easily, finishes up smoothly, takes glue readily and is an excellent substitute for the more expensive white pine. It is not, however, easy to find this quality in the market. There is doubtless enough of it for all purposes, but the purchaser must specify "thoroughly dry, No. 1, yellow poplar," and insist upon its being just that if good results are to be expected.

While the white varieties of poplar are usually much harder than the yellow, and more liable to warp, there are certain uses to which this may be profitably put on account of its cheapness. This is in making such core boxes as are formed on the machine. When used for this purpose it will be found easier to work and not as liable to warp as hard maple, which is much in favor for this work. From the quality of the wood it will wear smooth and does not seem to be as injuriously affected by wet sand as other kinds of wood usually used for this purpose. This may be new to many patternmakers, but is it a fact that thousands of core boxes are being made annually of this usually despised material.

Butternut.

In a large concern in the west many thousands of feet of butternut lumber was worked up into patterns with results very satisfactory to the patternmakers, the foundrymen and the proprietors. Not only were large patterns made of it, but many small patterns for malleable iron work where there was much "gluing-up and digging-out" work to be done. It was found to work very easily, even across the grain, it cut smoothly, finished up easily and when varnished showed a fine, smooth surface. It was never known to warp. In fact it made a good substitute for the more expensive red cedar and mahogany for light patterns. Drawing boards and the tops of drawing tables were also made of it and proved very satisfactory.

Cherry.

Of the harder woods, when used for fine pattern work cherry has always been the favorite on account of its strength and rigidity, but some qualities have a disagreeable tendency to warp, which detracts much from their usefulness. The varieties of lighter color and weight, and of straight grain

seem to be the best adapted for pattern work. One of the most useful purposes to which this wood can be put in patternmaking, is the making small, loose pieces of patterns composed of softer woods, and in forming their parts or exposed angles or corners upon such patterns.

FIG. 1—PLAN OF LUMBER DRYING KILN PROVIDED WITH HEATING COIL AND FAN BLOWER

Mahogany.

While mahogany will probably always remain the wood best adapted for making small and light patterns, red cedar or bay mahogany, as it is sometimes called, is an excellent substitute for many purposes. Mahogany is the most expensive wood used in patternmaking, its high cost being supposed to be offset to a great extent by the ease and accuracy with which hand work can be done upon it, these conditions tending to an economy in the labor costs. But the writer has seen many excellent patterns made of butternut lumber which cost scarcely more, and sometimes less than first quality white pine, and which for economy of labor cost and excellence of workmanship would compare favorably with the mahogany patterns.

Maple or Birch.

Hard maple or birch may be used for core boxes with good results, although as has already been said, white poplar offers a cheaper substitute and one costing less to work up. Hard maple is a difficult wood to work by hand, while birch works much more easily. Both are quite liable to warp under the action of wet sand. Black walnut is generally subject to the same limitations as hard maple, and hence is seldom used for a pattern when more appropriate woods are available.

Kind of Wood to Buy.

The foregoing being the conditions under which pattern lumber is used and the availability of the different kinds of wood, the question of the kinds that should be bought will be governed,

(1), by the class or classes of patterns to be made, and (2) by the state of the lumber market at the time the purchase is made.

As to the first condition, if the patterns are a general run of machine patterns it will be necessary to buy pine or yellow poplar as the soft lumber, and cherry as the hard lumber. The soft lumber should be bought in two grades, first and second quality, as the price of the second quality will usually be from $8.00 to $12.00 less than that for first quality, and for many uses will answer equally well. Should there be a difference of $15.00 to $20.00 per 1,000 feet between first quality pine and first quality yellow poplar, the poplar is the lumber to buy. A difference of $5.00 to $8.00 will hardly be sufficient to indicate the purchase of yellow poplar, as most patternmakers at this time are not well enough acquainted with its use to work with quite the same ease and efficiency with poplar that they would with pine. Lumber bought at any great distance from the plant should be sent in the rough. If it is planed before shipping, the surfaces will be marred and soiled in handling. All pattern lumber should be shipped in box cars to protect it from moisture.

The proper dimensions will generally be 1-inch boards and 1¼, 1½, 2, 3 and 4-inch planks. If the patterns are mostly of moderate dimensions the 4-inch planks may be omitted. Usually 2-inch planks will cost from $2.00 to $5.00 more per 1,000 feet than 1-inch boards, and 3 and 4-inch planks correspondingly more. Consequently the requisitions for anything over 2 inches thick should be looked into, the necessity for such dimensions be specially approved, and the quantities kept down to actual needs.

The widths of pattern lumber should ordinarily be "12 inches and wider," although if there is a reduction in price of $2.00 or more per 1,000 feet for "8 inches and wider," and the patterns to be made are of moderate dimensions, the lower quotation should be accepted. Pattern lumber comes in various lengths, even in the same lot, and runs from 10 to 18 feet in length, 12 feet being a common length. Butternut, when in the market, is purchased along the same lines as pine and yellow poplar.

The other kinds of wood used in patterns and core boxes are generally so much less in relative quantity that they are usually obtained of local or nearby dealers and the purchases must be governed largely upon the conditions of the market. Quotations should always specify grade, thickness, minimum widths and lengths, and also to specify that the lumber is to be kiln dried.

It is important that pattern lumber should be cared for at once upon its receipt at the plant. Cherry, mahogany, and similar expensive lumber is usually taken to the pattern shop direct and receipted for by the foreman, who

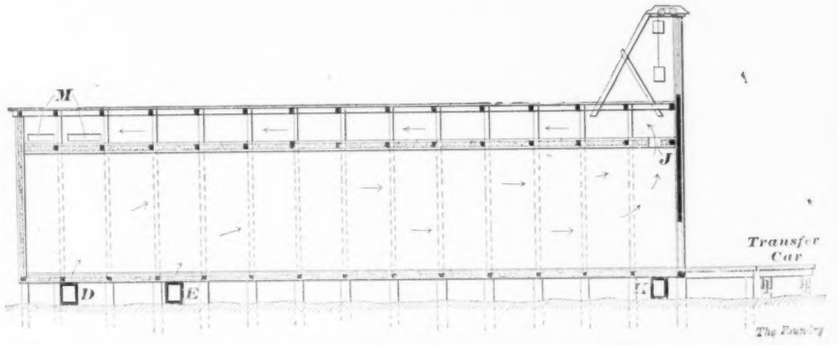


FIG. 2—LONGITUDINAL SECTION OF A LUMBER DRYING KILN

will provide a proper place for keeping it in good condition, as will be referred to later.

Drying of Pattern Lumber.

Unless under a special agreement, there is but a small proportion of pattern lumber that is kiln dried before its receipt by the consumer. Usually the best assurance that can be obtained from the wholesale dealer is that it has been "dried under cover," which is no assurance at all that it is in a fit condition for use in making patterns. An attempt to resaw a piece of this lumber will usually produce two badly warped boards, the dry outside always being the concave side, while the freshly cut inside shows the extent of the dampness contained in it and the high tension of the fibers of the outside surface of the board. The remedy for such lumber is obviously to so treat it as to equalize the moisture through the whole board and eventually to drive out as much of it as possible.

Lumber for patterns must be thoroughly dried, all the way through. In any event the influence of wet sand will tend to expand it, but it must be in such a condition that the expansion and the subsequent contraction, will be constant in all parts of the piece. There are only two methods by which this result can be accomplished. First, by taking the lumber into the pattern shop, where the temperature is comparatively high and the humidity low, and keeping it a sufficient time to extract all the moisture necessary. The second plan is to put it into a dry kiln or drying room for the same purpose. The pattern shop is in one sense a drying room, but as the temperature is far below that of a drying kiln the time required to fit lumber for the patternmaker's use is very much longer, and it is not unusual to keep lumber of doubtful condition in the pattern shop for a year or more before it is used.

When considerable quantities of lumber are used it is advisable to construct a regular lumber drying kiln that will meet all the requirements of the case. This should, of course, be designed according to the needs of the plant, and if the quantity of lumber used is small it may be simply a tight room with double walls of sheathing, the spaces filled with sawdust, and the room heated with a steam coil laid flat along the floor on each side, leaving a clear passage through the center. Near the top there should be several small openings that can be closed by slides when not needed for ventilating purposes, and near the floor other openings, with slides for admitting cool air. It is desirable to have a slight current of the warmed air flowing up around the lumber to be dried.

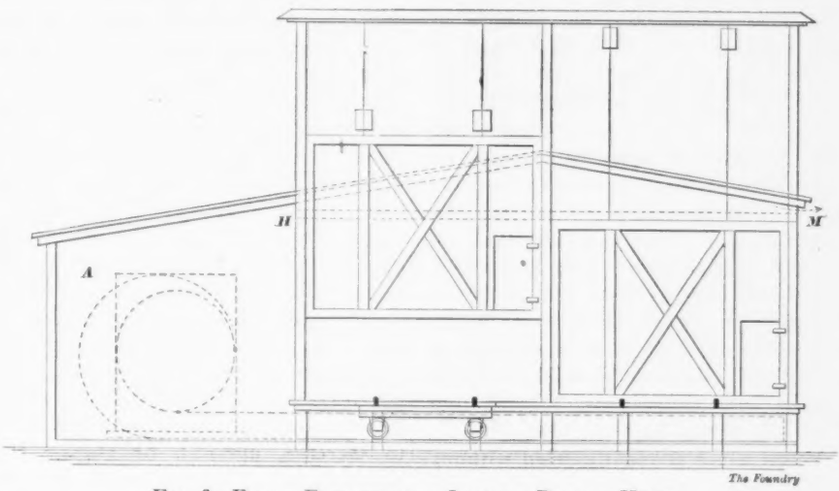


FIG. 3—FRONT ELEVATION OF LUMBER DRYING KILN

Composition of Wood.

It should be remembered that wood is composed of three different substances, namely; (a) woody fiber or cellulose, (b) constituents of sap and (c) water. The cellulose which forms the cells is identical in its composition with starch, and is the principal part of the bulk of the wood. The sap which permeates this structure is composed of albumen, sugar, gum, etc., forming what is called lignin, a soluble gum having the same elementary composition as cellulose. Upon the composition of this sap depends the character of the wood. Thus we find that in the coniferous woods, as pine, cedar, etc., it is resinous, in the beech and birch it is extractive, while in the oak, tannin is its characteristic. In growing wood, water forms over 90 per cent of the contents of the cells and partially or entirely fills the cavities of the lifeless cells, fibers and vessels. It is this water that occupies such an important position in considering the value and condition of all lumber as a commercial article. It is unequally distributed, the larger proportion being in the sap wood, or that nearest the bark. The importance of the water found in different woods may be realized when it is stated that in the coniferous woods, as pine, cedar, etc., it forms from 45 to 65 per cent of the weight of the sap wood, and from 15 to 25 per cent of the heart wood. In poplar 50 to 60 per cent in the sap wood, and 18 to 60 per cent in the heart wood.

A greater part of this water must be removed from the wood to render it fit for use. Ordinary drying of wood, even "under cover," as in sheds, is not sufficient as there is not only an insufficient quantity of water evaporated but that which remains is not very evenly distributed, and therefore the lumber will warp badly when it is cut up for use. When dried in a properly constructed and operated kiln all parts of the wood are equally dry, therefore the lumber may be used at once.

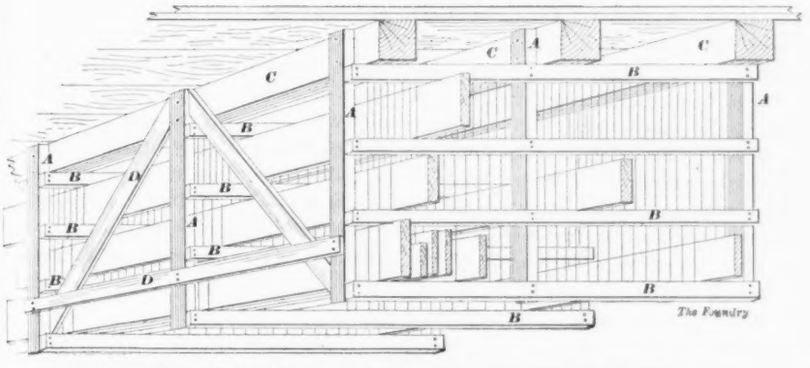


FIG. 4—AN OVERHEAD RACK FOR PATTERN LUMBER

Effect of Drying.

The shrinkage of wood during the process of drying is due to the fact that the walls of the cells shrink thinner and thinner as they become drier. Wood

having thicker cell walls, and therefore, being the heavier, shrinks most, while the water in the cell cavities does not influence the volume of the wood. The cells are of a great variety of size, form, thickness of the walls and of arrangement with relation to each other, therefore shrinkage is not uniform in any kind of wood. These irregularities produce strains, which increase with the difference between adjoining cells, hence warping and checking are the results. Frequently the checks exist when there is no outward appearance of such defects. They will be much greater if the wood is dried too rapidly than if more time is allowed for this process, but are never absent altogether. The more rapid drying of the outer parts of a piece will cause temporary checks, while permanent checks are caused by the greater shrinking along the rings than radially.

When wood is rapidly dried without sufficient moisture in the atmosphere the surface dries as a hard shell which shrinks before the interior has the opportunity to do so. The result is an inferior piece of wood having many of these interior checks. This is sometimes prevented by admitting steam to the kiln and so regulating the humidity of the atmosphere surrounding the wood that is being dried. If lumber has been previously dried in the open air this difficulty is not met with. Usually the harder the wood the more difficult it is to dry or "season" it properly. However, with a suitable kiln operated with intelligence and with a knowledge of the characteristics and requirements as here given, any kind of wood may be successfully dried, with a minimum tendency to warp or become distorted upon being cut up for use.

The wood of the coniferous trees, as pine, cedar, etc., dry more rapidly than the harder woods, but after coming from the kiln will absorb water from the atmosphere more rapidly, and if exposed to the weather with no protecting covering as of paint or varnish, will in time absorb nearly or quite as much water as it contained in its air-dried state.

Construction of a Drying Kiln.

When the quantity of lumber to be kiln dried is considerable and the ordinary dry room with a steam coil as previously suggested is not equal to the demands a regularly constructed drying kiln should be built. This may be located in one of the existing buildings whose walls may form a part of the drying rooms, or it may be a detached building constructed solely for the purpose of drying lumber.

Lumber drying kilns are constructed upon various plans, with quite different materials, and what is of more importance, several different methods of applying the heat to dry the lumber. Steam coils are used, but the pipes are liable to freeze in the winter time. In order to distribute the heat properly quite an expensive installation of pipes is necessary. Furnaces and stoves with various methods of distributing the heated air have been used with more or less success. But the system which seems to be best adapted to answer all the requirements is one in which the air is heated by drawing it over coils of steam pipes, by means of a fan blower, which also forces it through a properly arranged system of pipes or ducts which distribute the heated air to the points desired, the flow of air being regulated by a series of slides which may be operated so as to increase, diminish or change the direction of the flow of air at the will of the operator.

A drying kiln of this type is illustrated in Figs. 1, 2 and 3. It is built in two sections or rooms, for the reason that two different kinds of wood, or two lots of lumber containing different degrees of moisture cannot be dried in the same room at the same time. Should the amount of lumber to be dried be small and the occasions for the use of a dry kiln be infrequent, one room would be sufficient. The rooms are comparatively long so as to get the benefit of a large difference in temperature between the two ends, by which the lumber, being loaded upon a car and placed at the cooler end, may be gradually advanced through the varying temperature to the highest point at the further end. This is in accord with the Sturtevant system of drying lumber.

While brick is an excellent material for the walls of a dry kiln it is not necessary, as wood can be used with equally good results. The method of construction is shown in the plan Fig. 1, the longitudinal section Fig. 2, and front elevation, Fig. 3, showing the fan house as a portion of the structure. The foundations may be brick piers, or posts set deep enough in the ground to have their lower ends below frost, and surrounded by broken stones well rammed in. The floor is two thicknesses of 1-inch boards, between which is a thickness of building paper. Beneath the usual floor timbers is another thickness of 1-inch boards and the spaces are filled with sawdust. The side walls are similarly constructed, the double thickness being on the outside. The rooms are 9 feet high, the ceiling being formed of a thickness of boards above and one below the overhead timbers with sawdust in the spaces. The roof is of any good construction. The same construction extends over the fan house. The doors fill the entire width of the front of the rooms and slide vertically in grooves. They are counterbalanced by weights as shown.

Referring to Fig. 1, in the fan house A is located a cased heating coil B, connected with the fan blower C, from which heating ducts D, E, run beneath the floor of the dry rooms, connecting with the openings F, G, through which the heated air rises and flows toward the front of the rooms, where it may be allowed to escape upward through the opening J, Fig. 2, into the space between the ceiling and the roof, by which passage it returns to the rear end and hence over the side wall at H, Fig. 3, into the fan house, and again passes through the heating coil and fan. If the moist air from the outside is needed, it may be admitted directly into the fan house, or a certain amount of outside air may be let in by way of the cold air duct K, and through the openings L in the floor at the front end of the dry rooms. In this case a portion of the heated air passing back between the ceiling and the roof must be allowed to escape from the sides of the buildings at the rear end by the openings M, under the eaves. These arrangements give a perfect control of the direction and the intensity of the air currents, and in connection with the gradual movement of the carload of lumber from the cool air at the front to the high temperature at the rear form an ideal system for the rapid and yet thorough drying and seasoning of lumber.

Using the Drying Kiln.

In the use of the dry kiln the lumber is placed upon a flat car, so arranged that the edges of the lumber are one or two inches apart and separated vertically by piling sticks 1¼ to 2 inches square, so as to provide ample air passages. Canvas curtains at the sides, top and bottom are arranged to fit closely to the lumber so as to force all the heated air through the spaces between the boards or planks. The car is constructed with the usual plank top omitted, in order to allow the free upward passage of the warm air. A transfer car is provided in front of the charging platform, by which means loaded cars may be conveniently moved from one room to the other.

Care of Lumber in Pattern Shop.

The proper care and arrangement of lumber after it is received in the pat-

tern shop is a matter of much importance; first, as to keeping it in proper condition for use; and second, as a matter of economy in handling and cutting it up. Lumber is frequently piled up in such a way that several different thicknesses are contained in the same pile. It may be argued that it should be sorted and each thickness piled separately. This will occupy a considerable amount of floor space, and it will be found in practice that although it is sometimes attempted, it is seldom done, and if the method is one started by a careful pattern foreman, the different thicknesses will soon become so mixed that the care in sorting them out is wasted. Further, if lumber is so sorted and piled there will be some thicknesses of which there will be but few boards, making a pile only a foot or two high. These piles are liable to be walked upon and the surfaces so defaced and soiled with dirt as to be unfit for use in good pattern work.

In well managed pattern shops it is the practice to keep on hand a quantity of lumber planed slightly thicker than the regular thicknesses habitually used, and which may be finished to the following dimensions with the hand plane, all thicknesses from ¼ to 1 inch increasing by 16ths, and by 8ths from 1 to 2 inches. This enables the patternmakers to select at once the lumber suited to the different parts of the pattern on which they are working, without the delay and loss of time required to plane up a small quantity of lumber as it is wanted for each job.

The lumber being thus prepared it is necessary to provide some efficient and convenient method of storing it. So far as the writer has observed in practice there is no better method in use than that of a rack in which the lumber is placed on edge with dividing strips between individual boards and planks. Such a rack may be built upon the floor in some suitable corner where it will be convenient of access and yet as much out of the way as possible; or it may be suspended from the overhead timbers. The objection to the first plan is that it often occupies a good deal of valuable floor space. The only objection to the suspended rack is the additional labor of putting lumber into it and taking it out when wanted, in consequence of its elevated position. It should be remembered however, that the pattern lumber is of comparatively light weight, and that a large proportion of lumber thus stored is of the thinner kinds.

A convenient overhead rack may be built as shown in Fig. 4. Three frames, each composed of the uprights A, A, A, and the cross bars B, B, B, B, are bolted to the overhead timbers C, C, C, and held in rigid positions by the braces D, D, D. The lower, horizontal bars B, should be about 6 feet 6 inches from the floor. Vertical rods or strips run from one to the other of the horizontal strips B, B, for the purpose of supporting the lumber on edge. These may be composed of ⅝ or ¾ inch wood dowels passing through holes in the strips B, B, or of square strips nailed to these strips. The round dowel pin stock is preferable and more convenient when running lumber in and out of the rack. These rods should be placed only slightly further apart than the thickness of the lumber, otherwise the inclined position of the thinner boards will have a tendency to warp them. This rack should be designed to hold lumber enough for several weeks supply, as a matter of economy of labor in planing to the different thicknesses, and for the convenience of the patternmakers using the lumber. They will usually prefer to use lumber that has been in the rack a week or more, rather than that just planed, even if the lumber has been previously kiln dried.

In the effort to increase the interest of the patternmaker in his work and to increase his efficiency as a shop worker, there are no more potent factors than those of providing him a good and convenient shop and good materials to work with; and in the list of materials and supplies with which he is is provided, there is nothing that he will so much appreciate as good lumber.

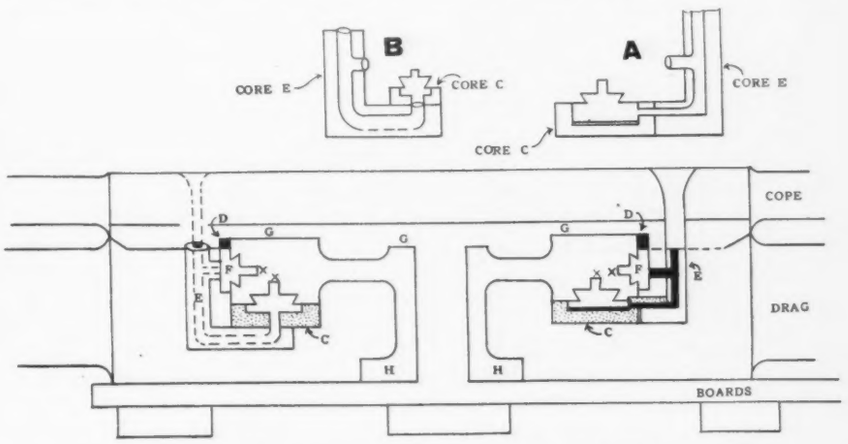
CASTING BRASS RINGS INTO CAST IRON SEATS

BY LOUIS LUHRSEN

QUESTION:—I would like to know how hard brass rings can be cast into cast iron seats.

Answer:—In proceeding to cast hard brass rings into cast iron seats the side of the casting G, shown in the accompanying illustration, should be placed on a follow board and the rectangular block D should be slipped around the casting. The loose ring F is then put on the block, the thickness of the latter governing the position of the ring. Core D, which has a recess representing the thickness of the metal, is then put in its place. The gate core E which is made in two halves and pasted together, is attached as shown in the illustration. The drag is then put on, and wooden wedges are placed between the casting and the side of the flask to avoid moving when the flask is turned over.

When the gate shown in plan A is used it will be necessary to file a gate in the side of the ring core C to meet the opening in the bottom of gate core E. When plan B is chosen a gate will have to be made in the bottom of ring core C to meet the opening in the gate core. Both gates will distribute the metal with equal velocity, although one strikes the side and the other the top of the recess. This point must be taken



METHOD OF CASTING BRASS RINGS INTO CAST IRON SEATS

into consideration, inasmuch as brass run against a cold surface of iron will chill quickly, and if poured too slowly the casting will be lost. The drag is then rammed up and the bottom board is rubbed to a bearing,

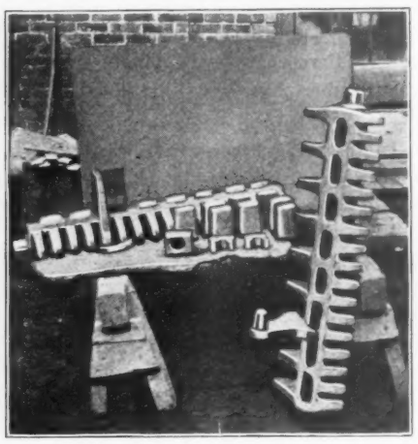


FIG. 1—LOCOMOTIVE GRATE BAR AND PATTERN. THE CASTING IS MADE WITHOUT CORES

especially at H H to avoid settling down. The mold should then be rolled over and the follow board and resting block D removed. The parting should be made on top of ring F and the gate should be plugged to keep out the sand. Add a few pop gates, ram up the cope, draw out the ring F and the operation is completed.

The success of casting brass on iron depends, to a large extent, on cleanliness. The casting should be slightly warmed and all dampness should be expelled. Dovetailed recesses should be bright and rough, and the metal very hot. If the metal is too hard, ring F is liable to crack on account of its tendency to contract towards the iron casting. Some allowance should be made for

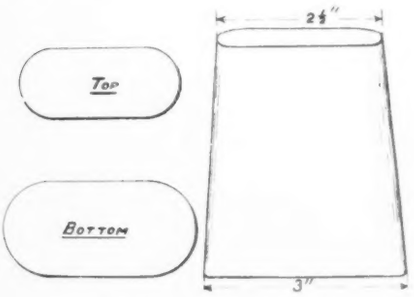


FIG. 2—THE LARGE CHILL

the difference in the contraction of the two metals. Brass running against iron will naturally close its grain. In this case the rings are only ⅜ of an inch thick, and a soft and tough metal can be used and the desired hardness can be obtained. Attention is directed to the points marked X which are merely ⅝-inch holes and any desired size can be used. We use them on our work in addition to the dovetailed recesses. The core C is made solid, the outside and inside diameters corresponding to the face of the casting.

THE USE OF CAST IRON CORES IN LOCOMOTIVE GRATE BAR MOLDS.

BY LOUIS LUHRSEN

A locomotive grate bar which is made without green or dry sand cores is shown in Fig. 1. The follow board shows the pattern in position. Half of the end bearings are made in green sand and the upper half with a cast iron chill. The chill which forms the journal for the shaker bar is hung to the arm and the sand is tucked under. This chill has a hole drilled through it to receive the tapered steel pin which forms the opening through the journal for the cotter pin. The taper of the pin opening in the chill is 1/16 inch and is sufficient to permit

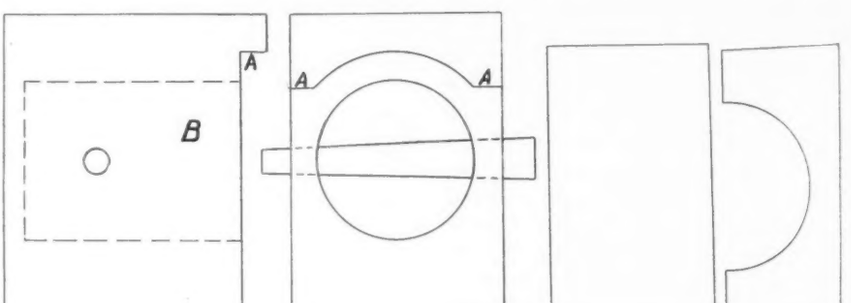


FIG. 3—CHILLS FOR THE SHAKER BAR JOURNAL AND THE END CHILL

of the pin being driven out easily. The taper of the large chills through the center bar is ½-inch. A smaller taper is liable to result in the breaking of the bar when the chills are knocked out of the casting. We experienced this difficulty and increased the taper from ¼ to ½-inch.

The chills for the end bearings, as well as the center chills, are oiled before they are placed in the mold. They are also given a coating of steel core wash, which is mixed with denatured alcohol and dries very rapidly. After the bar has been cleaned it is ready for the fire-box and requires no machine work. Views of the large chill are shown in Fig. 2, and the chill for the shaker bar journal as well as the end chill, are shown in Fig. 3. The shoulder at A, Fig. 3, forms a guide as well as a rest for the chill when the same is hung on the lug. This shoulder is made deep enough to cover the lug half way and prevents the sand from geting into the journal cavity B.

BRASS MIXTURE FOR SAFETY VALVES.

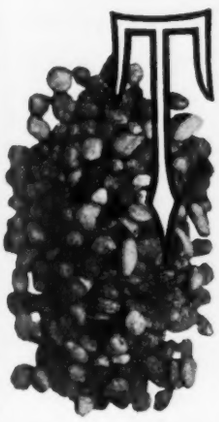
Question:—Will you kindly furnish us a mixture for safety valves that will withstand a hydraulic pressure of 300 pounds. We tried a mixture containing copper, 50 pounds; tin, five pounds; zinc, 2½ pounds; aluminum, 1½ ounces. At a pressure of 175 pounds the castings leaked badly.

Answer:—You would have had better success if you had omitted the aluminum, as this metal should never be used in any alloy that must withstand a high pressure. It is particularly bad in any alloy of bronze, and is never used in such metal, but is occasionally added to yellow brass to improve the casting qualities. Your mixture would be greatly improved by leaving out the zinc and substituting one pound of phosphor tin. The following alloy is also recommended: Copper, 90 pounds; tin, 10 pounds; yellow phosphorus, four ounces. When handling phosphorus great care should be exercised, and the chemical should be kept under water at all times. It can be secured in one pound cans, and after it is opened it should be plunged into water and should always be submerged. When weighing any desired quantity a small tin can or any suitable vessel containing water, is balanced on the scale, which is adjusted to weigh the amount required. The phosphorus is then quickly transferred to the balanced vessel until the required amount is obtained. The weighed phosphorus is carried to the furnace, the cover being half removed, the phosphorus is tossed onto the bath and is mixed by stirring. A pair of tweezers should be used in handling the phosphorus at the furnace. In this case, phosphor tin can be used to advantage. A good mixture containing this alloy follows: Copper, 90 pounds; tin, 8 pounds; phosphor tin, 2 pounds. If the phosphor tin or yellow phosphorus is difficult to obtain try the following alloy: Copper, 90 pounds; tin, 10 pounds; zinc, 2 pounds. K. K.

THE SAND BLAST IN THE FOUNDRY---II

Discussion of the sand and gravel used for cleaning iron and steel castings---Arrangement of the sand blasting department

BY JAMES M. BETTON



THE value of the sand blast as a cleaning agent depends upon the quality of the sand used and this item may become an important one in the expense of operating the outfit, especially if the sand has to be brought from any distance. The sand should be hard, sharp and clean, free from all clay, soil, mica and other substances that tend to create a dust and have no cutting power; these can usually be washed out, permitting the user, frequently, to avail himself of local deposits of sand or gravel.

The sand should be thoroughly dried before using, either by spreading it over a large area, as the floor of a shed, or by using a drier in the form of a sheet iron pan under which a coil of steam piping is located, or a slow fire maintained. A hopper drier erected around a small stove or steam coil can also be used. The flatter and larger the surface the quicker each batch of sand will dry and in the hopper driers the process can be hastened by inserting into the damp sand, sheet iron tubes perforated with holes, to allow the steam and vapor to escape.

Drying Sand.

Care must be taken in drying sand over a fire, to avoid overheating it. An excess of heat calcines it, destroys its strength and cohesion, and causes it to break into fine dust upon striking the article to be cleaned. Its force or cleaning power is impaired, and an excess of dust formed, which must be removed.

After drying, the sand should be screened through a No. 8 mesh screen to remove stones and other articles liable to interfere with the flow through the nozzle, and if it is desired to use sand of a special grade, a screen with appropriate mesh should be used.

While fine sand can be used on any work, quicker and often better results can be obtained by using a coarse grade or a fine gravel, that will pass through a No. 6 mesh, and for the ordinary run of iron castings and for steel castings, this gravel or grit will be found to be of the greatest value, as it stands, the impact on the iron, shatters slowly, and much of it can be used over a number of times, the proper grading being obtained by the addition of new material.

Screening the Used Sand.

After the sand has been used, there remains on the floor, dust from its own particles, a portion of good sand that has not broken or is in large enough particles to still do good work, and a considerable quantity of fine burnt sand that adheres to the casting and which is of no value as a cleaning medium, and which if used only adds to the dust from the operation.

Before refilling the sand tank, a portion of the cleaning floor should be swept off and the sand screened through a double slanting screen of a mesh that will separate large particles, stones, nails, bits of iron, etc., from the good sand, which will be retained by the lower screen, the dust passing through both meshes and removed by hand. This dust can be used for cores and a part of it also for parting material.

It is a saving of time to screen the sand after using and before putting it back into the sand tank, to remove large pebbles, scraps of iron, bits of wood, nails, paper, and other foreign particles that will find their way into a sand blast room, and will surely plug the nozzle, if they do not seriously interfere with the proper delivery of the sand from the sand tank. From one sand blast two handfuls of nails were removed, from another a number of blocks of wood and a piece of lath two feet in length, and in another case a ¼-inch nozzle was plugged by a burnt fire cracker,

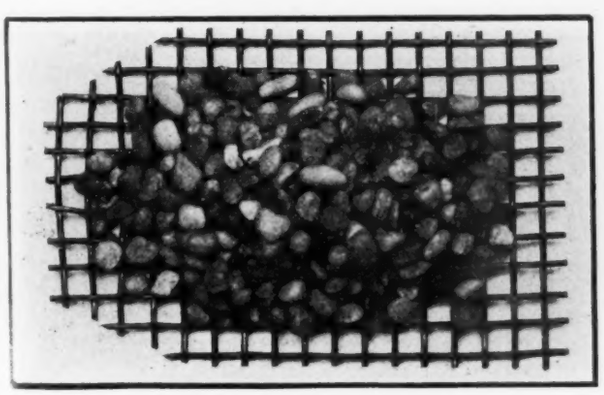


FIG. 1—A CAPE MAY GRIT FOR CLEANING IRON AND STEEL CASTINGS

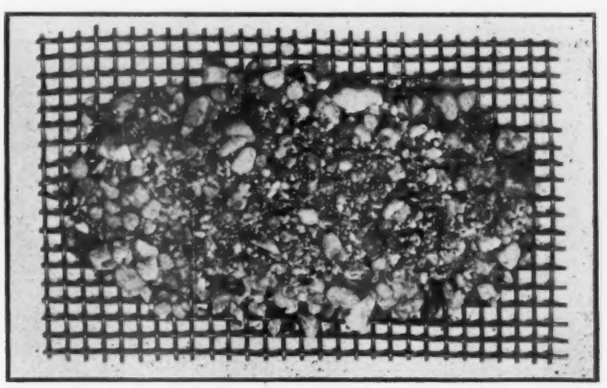


FIG. 2—A LONG ISLAND GRIT THAT HAS BEEN THROUGH THE SAND BLAST SEVERAL TIMES

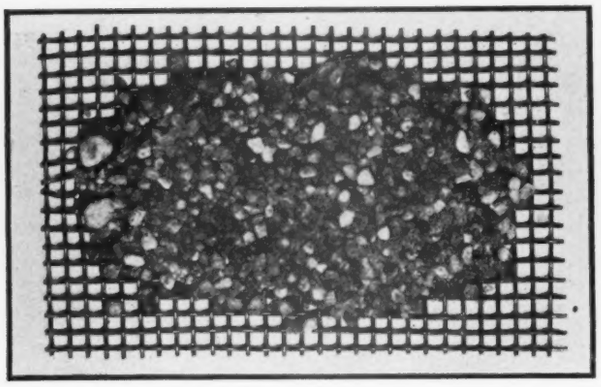


FIG. 3—A FINE GRAVEL FOR CLEANING IRON AND STEEL

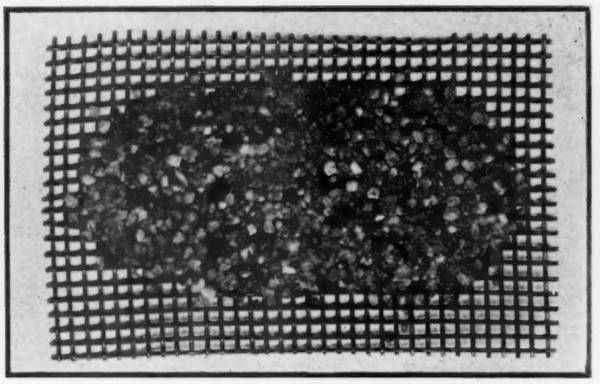


FIG. 4—A FINE GRADE OF NATURAL SAND FOR GENERAL WORK ON IRON.

the remains of a Fourth of July celebration in the sand pit.

Use of Local Sands.

The dictates of economy point to using as freely as possible a local sand, if this is readily obtainable in good quality and grade, from lake, river, shore or pits, if it can be delivered at the foundry at a reasonable price, otherwise recourse may be had to the excellent Cape May, New Jersey, and Long Island sands, which are offered at a reasonable price per ton f. o. b. point of shipment, but on which the item of freight is often a serious problem. Good quartz or silica sands are obtainable in Indiana, Michigan, Massachusetts and other states, and there are a number of concerns that make a specialty of crushing and grading sands, which have the advantage of being true to grade, clean, and free from dust.

Various Grades of Sand and Gravel.

The accompanying illustration shows various grades and qualities of sand and gravels that have been used successfully in cleaning iron, steel and brass castings, and may serve as a suggestion or guide in the selection of sands, means of comparison being made by the wire screens shown in connection with the samples, all of which are reproduced in actual size.

Samples of Sand.

A Cape May grit for cleaning iron and steel castings is shown in Fig. 1. This is known as grade No. 6, does excellent work and can be used many times.

Fig. 2 shows a Long Island grit that has been through the sand blast several times under an air pressure of 20 pounds, and was used for cleaning gray iron castings. The dust is burnt molding sand of no value for cleaning and should be screened out. The percentage of good grit is readily seen. This is grade No. 10.

A good, natural, fine gravel of value for cleaning steel and iron, grade No. 10, is shown in Fig. 3.

A finer grade of natural sand, grade No. 12, of great value for general work on iron, is shown in Fig. 4.

An excellent, moderately fine, natural sand, free from dust, for general foundry use, grade No. 20, is shown in Fig. 5.

A natural, Cape May sand, moderately fine, clean, valuable for general foundry use, grade No. 18, is shown in Fig. 6.

A natural bank sand, moderately fine, containing a large amount of fine sand of good value, grade No. 24, is shown in Fig. 7.

A very evenly graded manufactured sand, which can be used with good results on steel castings, is shown in Fig. 8. This is very clean and excellent for cleaning steel sheets or surfacing metals on account of its regularity of grain. It is graded No. 40.

An artificial silica sand, grade No. 100, that flows like water, is shown in Fig. 9. It is used for the finest finish on metals, glass, jewelry, etc., and is a very valuable sand.

A natural bank sand, clean and sharp, valuable for general foundry cleaning purposes, grade No. 14, is shown in Fig. 10.

Cleaning Rooms.

In considering the application of the sand blast to foundry work, too often this becomes a matter of fitting in the sand blast to any odd room or corner that is not used for some other purpose. This may or may not be convenient, probably not, and often the room is so cramped and inconvenient, with no means of removing the dust, that it is difficult, if not impossible, to find men who will steadily work in it.

Sand blasting creates dust from two

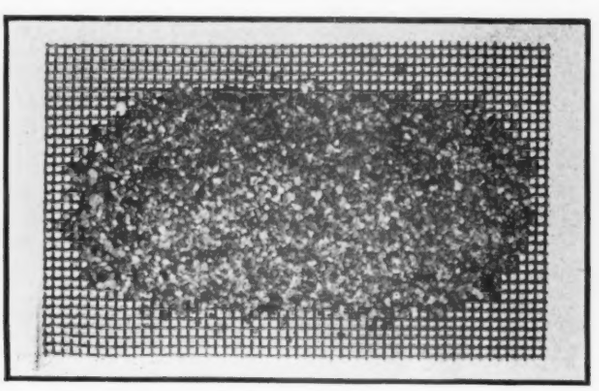


FIG. 5—A MODERATELY FINE NATURAL SAND FREE FROM DUST

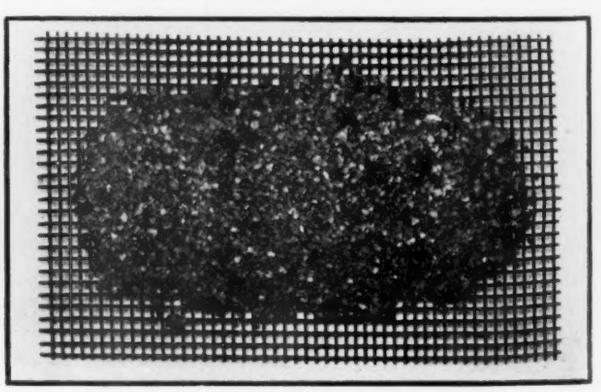


FIG. 6—A NATURAL, MODERATELY FINE, CAPE MAY SAND

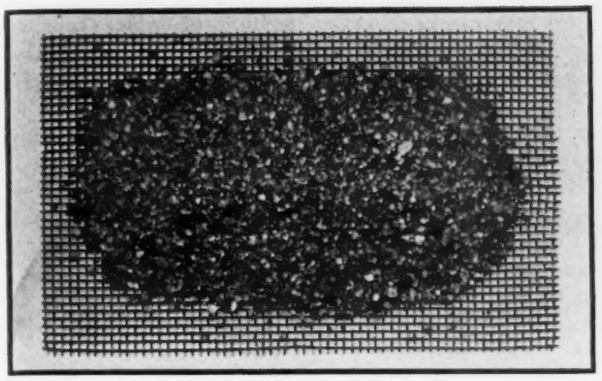


FIG. 7—A NATURAL BANK SAND

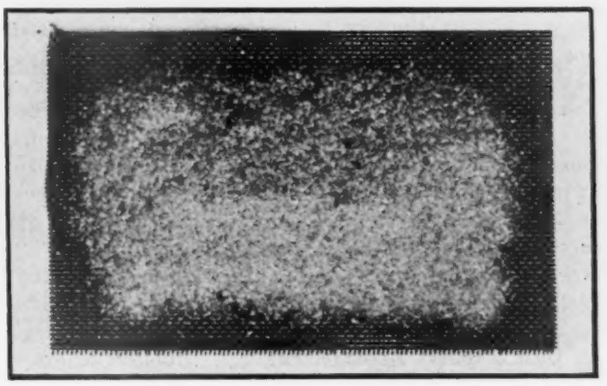


FIG. 8—AN EVENLY GRADED MANUFACTURED SAND

causes, first, from the shattering and powdering of the sand or gravel used and more from the scattering of the sand that is burnt on to the surface of the castings, especially in cored work, from which the cores have only been partially knocked out. It is not necessary to have much dust; some cannot be avoided, but if the sand used in the sand blast is hard and of large grade and has not been overheated, much of it will not be broken by contact with the casting and can be used again.

Dust will penetrate to and fill the entire cleaning room and seriously interfere with the proper cleaning of the work unless proper means to remove it is employed, for no man can do well when working in an atmosphere so laden with dust that he cannot see three feet ahead of him, leaving out the impossibility of his breathing this almost solid matter for any time, even with the protection of a helmet and respirator.

Removing the Dust.

It is obvious that some means must be taken to remove the dust as fast as it is made, and to keep it moving. An exhaust blower will do this and if located at the right point, the atmosphere can be kept comfortably clean. In many cases the blower is found connected to a sheet iron hood or inverted funnel which is suspended in the room above the work to be cleaned, as in Fig. 11. This is a bad arrangement, as only a small portion of the dust, that immediately over the casting, is affected and more circles and eddies around the sides of the room, especially in the dead-air space above the level of the lower rim of the hood, and is only partly removed.

If the lower rim of the hood is located at the level of the ceiling as in Fig. 12, a better result is obtained, but there are still slack air spaces around the sides and lower corners of the room, especially if this is thoroughly tight, allowing no inward leakage of air, and much of this dust lies stagnant and is not removed.

Location of the Cleaning Room.

The cleaning room for sand blasting castings should be conveniently located adjoining the foundry or near to it, so that the work can be taken from the sand, delivered to the cleaners and removed to the machine shop with the least possible handling. If it is reached by an overhead crane or by an industrial railway track, it is of advantage both in delivering and removing castings, and effects a saving of time.

The room should be at least 12 x 15 feet in area and of any convenient height, say 10 or 12 feet, depending upon whether an overhead trolley track is made use of. If adjoining the foundry, the end next to it may be left open, for an exhaust fan must be provided with enough air to work to advantage. The three remaining sides may have windows or not, as may be convenient, but the main light should be preferably obtained from an overhead skylight, and if windows are used, they should be located high above the floor, the sills being at a level of about seven feet, the space below being sheathed with corrugated or other sheet iron. The floor should be covered with heavy sheet iron over the whole area, no opening being necessary. The skylights and windows need not be made to open, as a constant current of air is maintained through the room by means of an exhaust fan, the air passing in through the open front and out through the fan exhaust.

This current is taken out at the level of the floor of the room, on the end opposite the opening from the foundry, through a vertical air duct

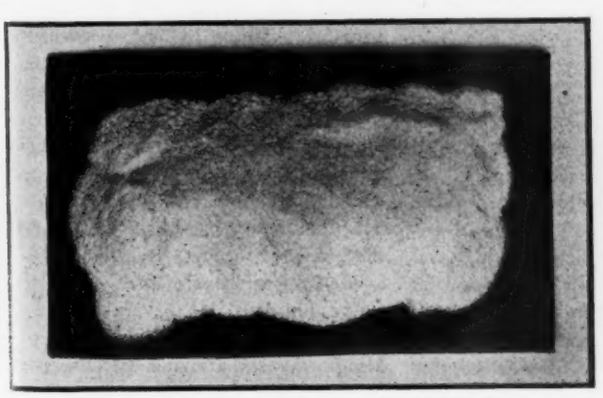


FIG. 9—ARTIFICIAL SILICA SAND FOR FINE WORK

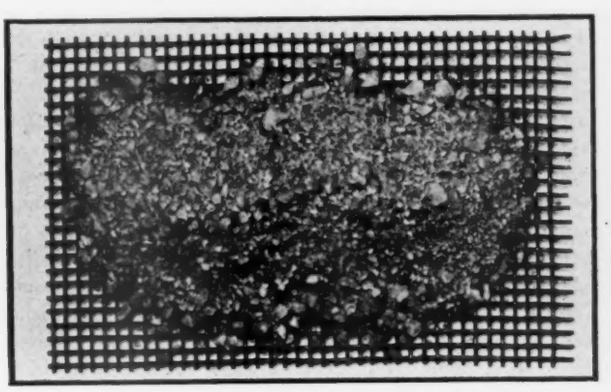


FIG. 10—A NATURAL BANK SAND FOR GENERAL FOUNDRY CLEANING PURPOSES

that is made by running a tight partition from the top of the room down to about two feet above the floor and about 18 inches out from the near wall. The upper part of this space is connected by spiral or other sheet iron piping, about 24 inches in diameter or larger, depending upon the size of the room, to the exhaust fan, which is located at the rear of and above the room and operated preferably by an electric motor.

Dust Exhaust Arrangement.

The dust is formed at a point from two to three feet above the floor, and the operator's face is between five and six feet from the same level; the fan being in operation, the dust is carried away from the man down towards the floor, a constant supply of clean air taking its place, flowing on through the main door which should be left partly open for this purpose. This arrangement is shown in Fig. 13.

The dust may be lead to a separator, of the spiral type, or other form which will separate the heavier portion and deposit it in a bin, suitably located, from which it may be drawn off from time to time, part used as parting sand and the balance otherwise disposed of, or the dust from the fan may be delivered out of doors through a plain pipe in isolated cases, or blown down into a tank containing a series of suspended cloth screens, constantly wet by trickling streams of water, on which the dust is held and washed off into a tank at the bottom in the form of mud.

The front of the room can be closed by light swinging doors or by screens that roll up, kept always partly open when the sand blast is working, to secure a proper amount of air for the fan. If the door and other openings are tightly closed, the air must strain in through cracks, causing unexpected currents, starving the fan, and preventing the proper removal of the dust.

As the sand blast is portable, it is very convenient to arrange the air piping with several outlets, as one on each side of the room, for cases may occur when it would be desirable to move over the tank and work from the other side of the room, rather than to carry the blast through a longer length of hose. Such extra piping and valves are not expensive, add to the completeness of the outfit, and will often save their expense on one job.

Arrangement of the Cleaning Room.

Put up suitable racks along the walls of the cleaning room to hang the hose on when not in use. These will lengthen the life of the hose very materially and will more than pay for themselves. Place the sand blast at one side of the room near the front, so that the sand will be directed generally towards the rear of the room, or in the direction of the exhaust current. This gives the heavy particles of flying sand time in which to settle down upon the floor. Put up hooks for shovels and wrenches, and keep them in their places when not in use.

Sand Blast Under Cleaning Room.

In some instances it is desirable to locate its sand blast underneath the cleaning room, in which case the room can be made of any convenient size, with overhead light and doors as required. In the floor is located an iron grating over a hopper, into which the sand falls or is swept. At the bottom of this hopper are arranged screens to separate stones, etc., which fall to one side, the good sand, which falls into a feeding hopper, and the dust, the heavier portion of which falls to a bin on the floor. The sand blast is located at the side of the feeding hopper, so that the good sand flows into it when directed, and the delivery from the sand blast to the cleaning floor above is made by iron piping or rubber hose, the latter giving the best wear.

Exhaust Fan.

An exhaust fan draws the dust down from the cleaning room and delivers it to a collector, and when properly proportioned it will keep the cleaning room entirely free from dust, the principle of removing the dust from the bottom and drawing it away from the operator being identical with that shown in Fig. 13.

In every case, the exhaust fan or blower should be of ample dimensions to allow of the quick removal of dust when running at a moderate speed and power.

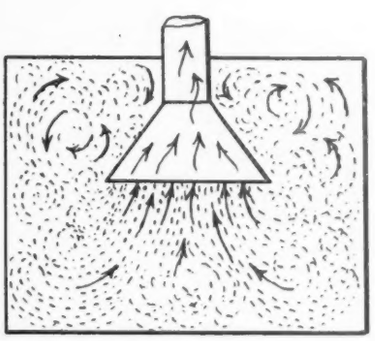


FIG. 11—BAD ARRANGEMENT OF SHEET IRON HOOD

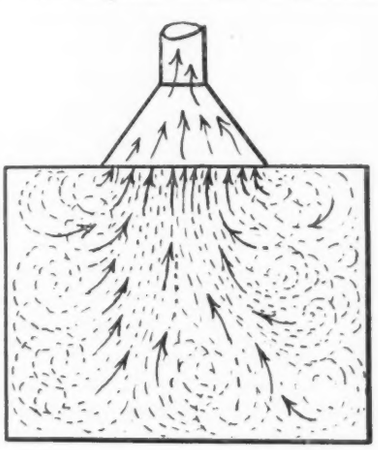


FIG. 12—SHEET IRON HOOD PROPERLY INSTALLED

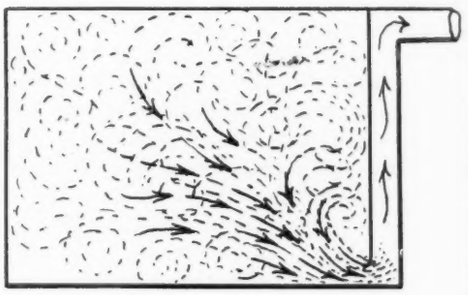


FIG. 13—DUST EXHAUST ON A LEVEL WITH THE FLOOR OF THE CLEANING ROOM

OBITUARIES.

John Miller, pioneer foundryman of the Mahoning valley, died at his home in Youngstown, O., Nov. 24 from heart failure. He had been identified with the foundry business in Youngstown for 50 years as a partner of Lloyd Booth, who died some years ago. Mr. Miller conducted the foundry and machine shop known as Booth & Miller, which is now a part of the United Engineering & Foundry Co.

L. L. Munn, president of the Arcade Mfg. Co., Freeport, Ill., died Nov. 23, aged 80 years. He had retired from active business for several years. Mr. Munn was one of the pioneers of the Middle West, arriving at Freeport in his younger days before there were railroads, making the trip from Vermont by stage and water to Chicago by way of Buffalo.

AN AUTOMATIC FOLLOW-UP SYSTEM*

Keeping records of orders in the foundry and laying out work for the molders --- Promise sheet

BY JOHN DOUGHTON

THERE are many factors that enter into the successful operation of a modern foundry, and among these are an exact knowledge of the cost of production, and the proper handling of orders. The subject of foundry cost keeping is now receiving more attention than heretofore. Foundrymen are beginning to appreciate the value of the methods used in other industries.

Undoubtedly, all foundrymen, especially those who come in close touch with the customer, have felt at some time or other the need of some effective method of handling orders so as to be able to give more satisfactory deliveries and thus prevent a great deal of complaint.

Prompt Shipments.

How to make and ship castings on time so as to keep each customer satisfied, is one of the problems confronting every foundryman, and any arrangement that will enable him to accomplish this should have his careful attention.

Every foundryman is aware of the importance of prompt deliveries in his efforts to secure orders, but frequently after an order has been received on the strength of certain promises of delivery, it is neglected or forgotten as far as any attempt to meet the promises are concerned. Many orders are lost because a prospective customer is not satisfied that his orders will receive proper attention, or else believes they will receive better attention by the foundry to whom he gives the order.

In many foundries, castings are made without any regard to the order to which they belong. When an order is received from a customer, it is duly entered, the patterns are placed on a shelf in the foundry, and unless the customer has specified when he must have the castings, the patterns may remain on the shelf until the customer inquires about them.

It may be that this customer has other orders in the foundry. Does this have any effect on the order in which the castings will be made? None at all. If the last pattern is a desirable class of work and calculated to swell the heat or tonnage, in it goes, crowding out castings less desirable for the foundry, but just as necessary to the customer. If the last pattern is an intricate or otherwise undesirable piece of work, it is allowed to remain on the shelf together with a lot of other undesirable work that has been allowed to accumulate. Some day the customer inquires for the castings. Some story is invented to pacify him, and everything turned upside down in an effort to get out the castings.

Accumulation of Neglected Work.

This neglected work so accumulates that when the day of reckoning comes, the foundry has a lot of undesirable work on hand that all the customers are calling for at the same time. This is not only a possible condition, but one that has been experienced time and again.

Another source of annoyance to the foundry as well as the customer is the accumulation of old orders that need cleaning up, some only half filled, but most of them needing but a few castings to complete the order. The reason for this accumulation of back orders is often found in the lack of proper provision for the discovery and replacing of defective castings. One result of this lack of proper methods is, that one day this customer is complaining about neglected orders and the next day it is some other customer, so that in an effort to keep them all satisfied, the foundry is kept in a continuous turmoil, often resulting in bad castings and bad tempers. Another disastrous result is that the customer becomes dissatisfied and is ready to change foundries regardless of price, provided he can be made to feel that his orders will receive better attention.

Simple Follow-up System.

By the adoption of a simple follow-up system this trouble and confusion could be avoided. It should be remembered that labor in the foundry differs from other work in this, that the machinist or other workman sees the product of his labor continually, and can replace any material found defective. The molder on the other hand does not see the product of his labor until the end of the day or it may be after many days. This feature of the foundry business is responsible for a great many of the troubles of the foundryman.

		MOLDER JOHN BROWN				MOLDER JOHN SMITH			
MONTH	DAY	ORDER	PATTERN	PIECES	HOURS	ORDER	PATTERN	PIECES	HOURS
Nov.	2	4820	B-1	2	10	4821	C-2 C-3	2	6
	3	"	"	"	"	"	C-2 C-3	"	"
	4	"	"	"	"	"	C-2 C-3	"	"
	5	"	"	"	"	"	C-2 C-3	"	"
	6	"	"	"	"	"	C-2 C-3	"	"
	7	"	"	"	"	"	C-3	"	"
	8	"	"	"	"	"	"	"	"
	9	"	"	"	"	"	"	"	"
	10	"	"	"	"	"	"	"	"
	11	"	"	"	"	"	"	"	"

The Foundry

FIG. 1—FOUNDRY LAYOUT SHEET

*Presented at the November meeting of the Philadelphia Foundrymen's Association.

There are various order systems in use in the foundry business and some are models of record maintenance. Few of them, however, follow up orders to insure their prompt delivery.

Purchasing Department Methods.

In looking for a solution of this problem, let us consider the methods used by an up-to-date purchasing agent for a large industrial plant. When he places an order for material, the first thing he does is to set a date when shipment is to be made; he bases this date either on promises made by the shipper or on his expectations of delivery. It would be practically impossible for him to go over the purchase orders each day and select those requiring attention, so he marks this particular order for attention on a certain date and when that date arrives he takes out this order and any others that may have been marked for the same date and gives them all attention. If any require still further attention he fixes the date and again marks the order as before, allowing none to be put away if unfilled, without being scheduled for future attention. By this method each purchase order is looked after systematically. By precisely the same method we can look after all foundry orders.

The System.

I shall not go into the details of making out foundry orders, but will describe an automatic follow-up system for keeping track of orders systematically until every item called for on the order has been delivered. This plan consists of laying out the work as fast as orders are received, assigning each pattern to a certain molder to be made on a certain day, and basing the completion of the order on the amount of work each molder has ahead of him. Each order is scheduled to be looked up on certain dates and all delinquencies are immediately reported and attention given the same. In other words, the foundry is operated according to a schedule.

To carry out this plan, three forms or sheets are required. The first is the foundry layout sheet, Fig. 1; the second the daily work sheet, Fig. 2, and the third the promise sheet, Fig. 3.

Foundry Layout Sheet.

The foundry layout sheet is ruled horizontally and in columns, each column representing a molder or floor. The spaces between horizontal lines represent working days. The lines are far enough apart to allow sufficient room for inserting four or five pattern numbers. When an order is received, the foundry order is filled out in the usual way, the foreman indicates on each pattern the time required for molding, the number of pieces to be made each day, and the molder who will make the castings. The order clerk then marks on the foundry layout sheet, according to the name of the molder, the number of the pattern and the number of pieces to be made each day, also the time required each day to make the castings. He carries this down until the total number of castings required is entered on the sheet, noting the date when the order will be completed, which is marked on the order as a record of the time when the castings are expected to be completed.

To illustrate—we receive an order for 20 castings to be made from pattern B-1. The foreman indicates on the pattern that it will require five hours for each casting, and names J. Brown as the molder. Consequently, 10 working days must elapse before the order is completed. Turning to the foundry layout sheet, and in the column alloted to J. Brown we enter the 20 castings. Assuming the order is received on the first day of the month and is the first order, we enter two castings for the first day, two for the next, and so on until the entire order of 20 castings will be completed on the 12th day. This date is marked on the order.

Another illustration, more involved, follows. The order calls for 10 castings No. C-2, and 20 castings No. C-3. The foreman says that it will require three hours to make each of the first and two hours for each of the second. He will make two of each per day, and assigns the job to J. Smith. In the column allotted to Smith we enter two castings No. C-2 at 3 hours each, making six hours and two castings No. C-3 at 2 hours each, making 4 hours, a total of 10 hours. While the 10 castings, No. C-2, will be completed on the 6th, the 20 castings, No. C-3, will not be completed until the 12th. This information is entered on the order opposite each item. While this man has a full day's work before him for the first five days, he has only four hours of the next five days, so that as the orders come in, we must fill in these days with work he is capable of handling.

Nov. 2, 1908

MOLDER	ORDER	PATTERN	PIECES	MOLDER	ORDER	PATTERN	PIECES
J. BROWN	4820	B-1	2				
J. SMITH	4821	C-2 C-3	2 2				

The Foundry

FIG. 2—DAILY WORK SHEET

Daily Work Sheet.

This layout sheet, when filled in as the orders are received, will show first, what work is assigned to each molder and the probable length of time it will take him to complete it, and second, by referring to any certain date we can see what work is laid out for that day. The next step is to let the molder know in a convenient way what he is to make. For this purpose we use the daily work sheet, Fig. 2. To the left is entered the name of the molder and opposite his name is entered the patterns he is to work on, and the number of pieces he is to make that particular day. This is made up from the foundry layout sheet, and should be made up the day before, so as to be ready for the molder in the morning. It should be posted in a convenient place so that it can be seen by all the men. It is a simple matter for the pattern carrier to use this sheet in getting out patterns for the molders.

The difference between the foundry layout sheet and the daily work sheet

is that the daily work sheet shows only the work laid out for one day and does not show the time assigned to any job. Our system so far has provided us with a means of knowing what to expect, the next step is to know if our expectations have been fulfilled, and it becomes necessary for us to follow up each order systematically.

Promise Sheet.

As stated previously, the date upon which we expect the complete order is entered on the copy of the order, so that by reference at any time to any order, we may know when it is expected to be completed. We now take the copies of the orders and enter the number of the order on the promise sheet, Fig. 3, opposite the date the order is to be completed. On the left of the sheet we list the days of the month omitting Sundays, allowing as many lines as may be thought necessary to each day. Opposite the respective dates we place the number of the orders according to the date they are to be completed, so that by turning to any one day, we have a list of the orders scheduled for completion on that date. As each day comes around we look up the orders that were to be completed that day. If shipment is made as laid out, nothing more need be done, but when shipment is not made, new dates must be entered on the promise sheet.

When it is impossible to keep a promise made to a customer, he should be notified. This will often forestall complaints and will create the impression in the minds of some customers that their interests have not been ignored. The successful use of the foundry layout and daily work sheets depends largely on the manner in which the promise sheet is checked up. It should be the duty of some one, each morning, to check the shipments of the day before. To do this, it is only necessary to take those orders opposite a certain date and see if they have been completed as scheduled, reporting on a special form any orders not completed. It would also be well to send to the shipping clerk a list of all orders promised for completion on the following day. This will give him an opportunity to get those castings ready.

Rush Orders.

There is one phase of this subject that has not yet been considered. In order that the system can be carried out successfully as planned no rush orders can be received. But this is a condition that is not likely to exist at any time in the foundry business. Customers will send orders for castings that are wanted at once, or are wanted before our ordinary routine would give them the castings. The foundry will also continue to make defective castings.

In order to provide for rush orders and the replacing of defective castings it will be necessary to allow sufficient time each week to take care of them. This time will depend on the conditions existing in each foundry. If it is found that it requires one full day a week to take care of rush orders and defective castings, we omit one day each week and lay out the work on the foundry layout sheet accordingly, or perhaps it may be best to omit two half days each week. For instance, it may be found from experience in one foundry that it requires nearly two days each week to handle this class of work, so that Tuesdays and Fridays may be allotted to the filling of rush orders and the replacing of defective castings. No work is assigned to these days from the orders as they are received, unless it is for castings that are wanted at once. The work for these two days is made up of rush orders and replacing defective castings, but it is not to be understood as meaning that defective castings cannot be replaced or rush orders filled on any but these two days.

Any system to be of real service must be elastic in its operation. If a rush order is received we crowd it in to the best advantage and here is where the value of the system appears. Usually, when crowding a rush order in, something else is crowded out and is often allowed to remain out, but we only crowd it along, not out, and as we have allowed the necessary time in the layout of our orders, no previously made plans are upset in our effort to get out this rush order. In entering this rush order in the foundry layout sheet we observe the same rules as in regular work, so as to know as nearly as possible the time to which work has been assigned. As replace orders are to be considered as rush orders, the same system applies. Sometimes the foreman underestimates the time required on a given job; he will also over-estimate on others, so that his estimates, if made intelligently, will balance up fairly well.

By the methods here outlined, it is possible to lay out the molding and shipping of castings of every size and weight regardless of the number of pieces wanted, the molding to cover a period of one day or two or three months or more if necessary, with the practical certainty that each piece will be molded, cast, cleaned and shipped on schedule time, including the filling of rush orders and the replacing of defective castings.

MONTH	DAY	ORDER	ORDER	ORDER	ORDER	ORDER	ORDER	ORDER	
Nov.	2								
	3								
	4								
	5								
	6	4821							
	7								
	8								
	9								
	10								
	11								
	12	4820	4821						

The Foundry

FIG. 3—PROMISE SHEET

USE OF STEEL PUNCHINGS.

BY W. J. KEEP

Question:—We charge 1,500 pounds of pig iron, 1,300 pounds of machinery scrap, and 200 pounds of steel boiler punches in our cupola, and use two pounds of ferro-manganese to each 1,000 pounds of iron in the ladle. Fine blow holes have resulted in the loss of a number of castings, which are also full of shot iron.

Answer:—Would suggest that you use ¼ pound of pure aluminum (not casting) to each 100 pounds of iron in the ladle. This is to be substituted for ferro-manganese.

A MODERN CAST IRON PIPE FOUNDRY

Description of the new plant of the Standard Cast Iron Pipe & Foundry Co., Bristol, Pa.

THE new plant of the Standard Cast Iron Pipe & Foundry Co., at Bristol, Pa., is now practically complete. Several of the departments are already in operation and one of the two big pipe foundries is ready for melting, while construction work on the other is being rushed. Aside from the fact that this is now one of the largest plants in the world for the production of cast iron pipe, it is of particular interest in point of location, design and equipment.

The Standard company is capitalized at $2,000,000. Its directory board and corps of officials include men of wide experience in the manufacture of pipe, and ample resources have been at hand to carry out every detail of their plans. Accordingly, the plant at Bristol may be considered as embodying all that is best in modern pipe practice; it is as nearly an ideal plant as can be designed and built, and is expected to show remarkable economies.

The property of the Standard company consists of a 137-acre tract just north of Bristol and extending from the main line of the Pennsylvania railroad on the west to the Delaware river on the east, a distance of a half mile. This tract is intersected by the Bristol and Trenton turnpike, and the section bordering on the river is occupied by the plant. A part of the opposite section is given over to an industrial village for the housing of workmen, and the remainder, all high and practically level ground, is reserved for later plans.

Two Large Pipe Foundries.

The pipe works proper consist of two large foundry buildings, each 105 x 475 feet, identical in design and equipment, fronting the turnpike. Each of the buildings, in turn, houses two casting units; that is, each half of the building has its own core and mold ovens and casting pits. The two units, however, are served by common cupolas, located in a front bay midway the length of the building, and by a common ramming machine, directly opposite the cupola house. Extending back from the center of each building is a pipe cleaning shed, 45 x 188 feet, leading to the coating house and thence through a shorter shed to the proving press house.

In the design of the plant particular attention has been paid to securing rapid and economical handling facilities, the crane equipment being remarkably complete. The stock yards for the pipe foundries are situated near the siding along the front of the building at either side of the cupola houses. In these yards iron, scrap and coke are loaded into industrial cars which are then run into the cupola house and lifted through a hatchway to the charging floor by a heavy traveling crane. It is possible that eventually the crane runway will be extended out through the sides of the cupola house to cover the stock yards, as provision has been made for such a change, should it be deemed advantageous.

Heavy Melting Capacity.

The melting equipment of each foundry consists of two Whiting cupolas, each of 108-inch shell, and a motor-driven Wilbraham-Green blower mounted on a platform immediately behind the cupolas. The large diam-

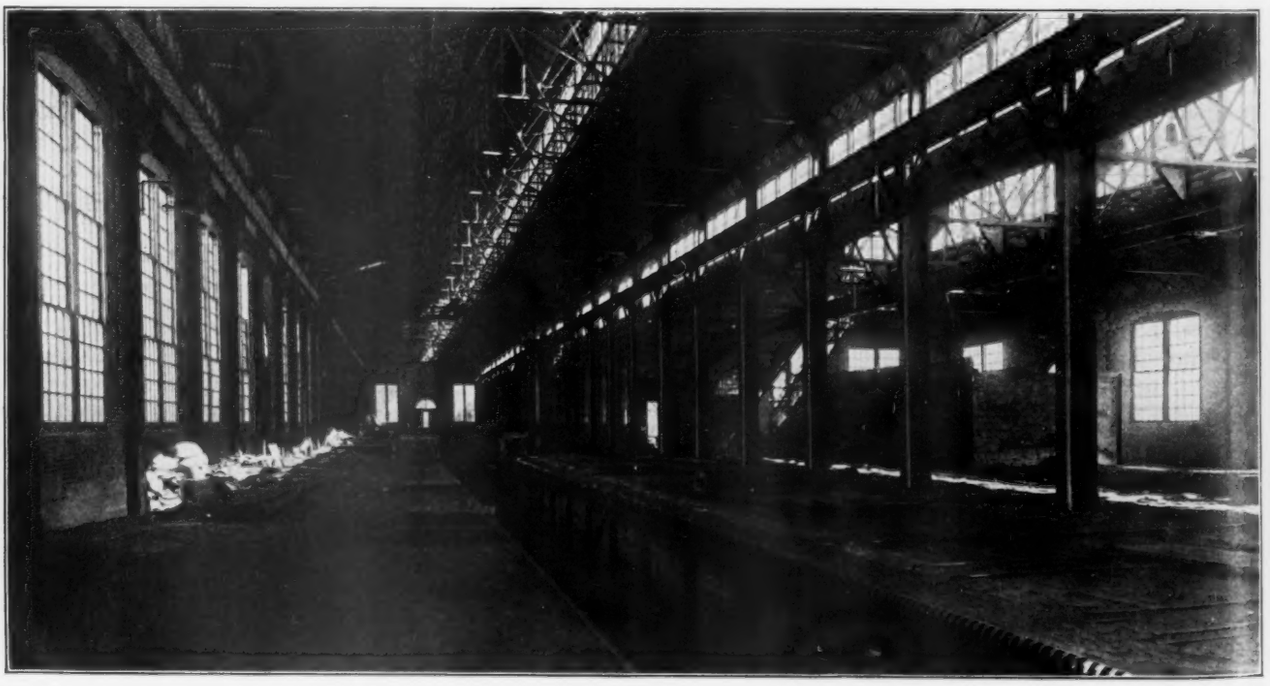


FIG. 1—NO. 1 PIPE FOUNDRY, CORE OVENS ON THE RIGHT

FIG. 2—INTERIOR VIEW OF THE MACHINE SHOP SHOWING FLASKS UNDER CONSTRUCTION

eter of the cupola shell permits of a very heavy lining, rendered necessary by the severe demands imposed upon the cupola in a pipe plant, and also secures a marked increase in melting efficiency. From the cupola the molten metal can be carried to the melting pits either by traveling crane or, if the cranes are otherwise employed, by a transfer track running the entire length of the building.

Sixteen core ovens are provided in each foundry—two batteries of four serving each unit. These are located at the rear and near the end of each building, conveniently close to the casting pits. They are coal fired from the back and are served by overhead runways immediately in front. Industrial tracks run into the ovens.

Pit Arrangement Followed.

The large mold ovens, two for each pit, are located near the center of the building and are built end to end. The pit which contains them extends back under the floor at one side sufficiently far to provide for the bringing in of coal and the removal of ashes. The other side of the depression is given over to a heavy continuous conveyor for transferring the flasks back to the ramming machine after the pipe has been shaken out. From this conveyor the flasks are delivered to a revolving table and pass under the mechanical rammer, an extremely successful machine, the rights to which are controlled by the Standard company.

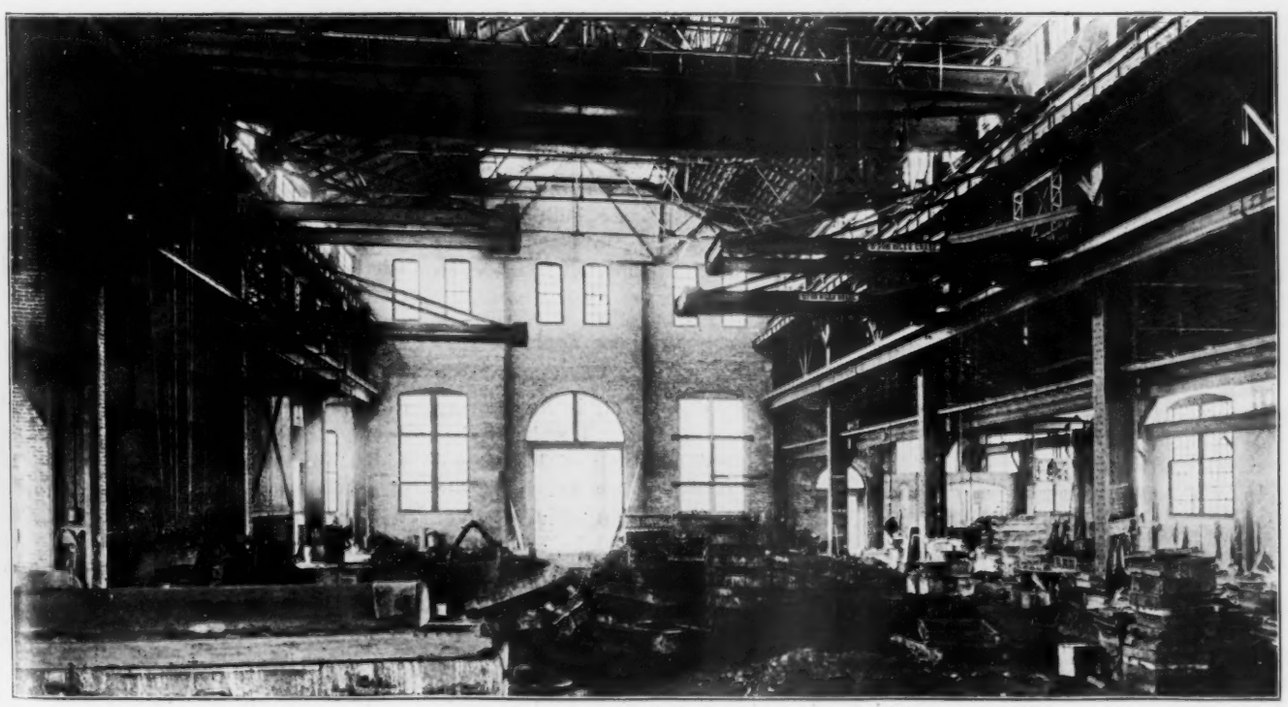


FIG. 3—THE GRAY IRON FOUNDRY FOR GENERAL WORK

The casting pits, located at the extreme ends of either building adjacent to the mold-drying ovens, are of concrete. Each half of the foundry is equipped with three traveling cranes, one for transferring the flasks from the blacking floor in front of the ramming machine to the mold ovens, the second for carrying the flasks from the ovens to the casting pit, and the third for pouring. These cranes, six to a building, are of Pawling & Harnischfeger make and are of 10 tons capacity each, though to meet the severe burden imposed by constant operation at high speed they are of the same proportions as standard 20-ton cranes. In the center of each building is located a 10-ton electric Pawling & Harnischfeger post jib crane.

Gravity Skid System.

After the casting operation, the pipe are shaken from the molds and loaded on transfer cars, which carry them a short distance to the cleaning shed and deliver them to inclined skids leading to the coating house. In this connection it should be stated that the entire site of the plant has been carefully graded so as to slope toward the river at the rate of ¼ inch to the foot. This, together with the fact that the various stages in the production of the pipe lead regularly down toward the shipping yard, the docks and the storage yards, explains one of the methods employed to secure economical operation.

In the coating house, an enclosed room 70 x 110 feet, the pipe roll automatically onto cars which run into the heating ovens in bays at either side. After treatment in the coating tank, they continue on skids to the testing house where a hydraulic proving press, built by the Watson-Stillman Co., is in operation. The storage and shipping yards are located between the testing houses and the railroad siding.

The General Foundry.

In addition to the two large pipe foundries, the plant includes a general foundry for the manufacture of fittings or specials, for molding flasks and for such general work as can be handled after these requirements are met. This building is 120 x 200 feet and is equipped with an Epping cupola of large capacity. Its crane equipment is also complete to an unusual degree, consisting of a 30-ton Niles-Bement-Pond traveling crane and four traveling jibs of 10 tons capacity each; the side bays are also fitted with traveling cranes.

In the cleaning house, a building 50 x 200 feet located between the general foundry and the machine shop, another traveling crane runs out through an open gable on a skeleton frame to cover the storage yard and siding. The removal of the cleaning department from one corner of the foundry building, as is the common practice, to a separate building when its dirt and noise do not interfere with other departments, is a commendable feature.

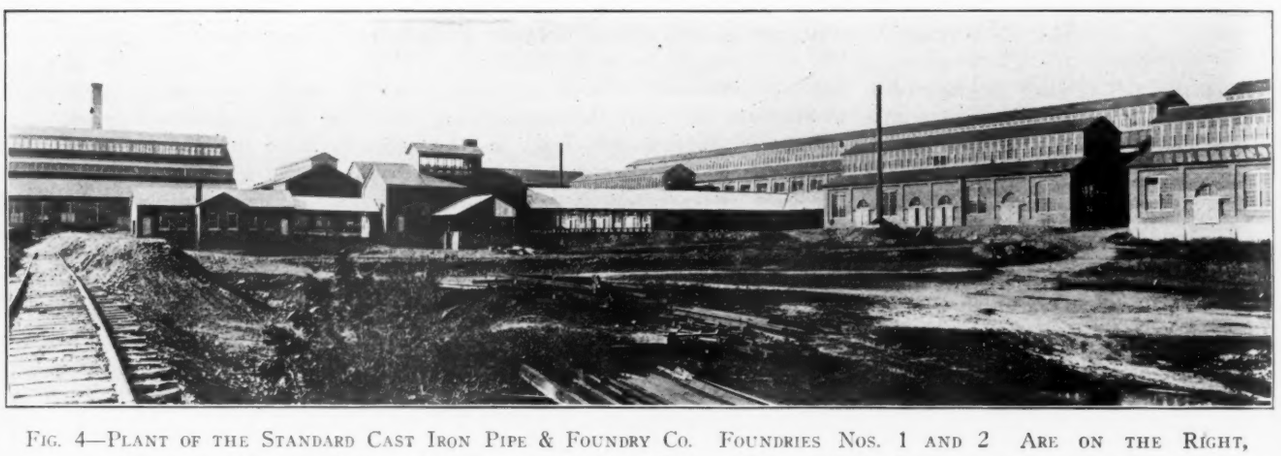


FIG. 4—PLANT OF THE STANDARD CAST IRON PIPE & FOUNDRY CO. FOUNDRIES NOS. 1 AND 2 ARE ON THE RIGHT, SHOWING CLEANING SHEDS, COATING AND PROVING HOUSE. THE GENERAL FOUNDRY IS ON THE LEFT

Heavy Machine Tools.

The machine shop, a well lighted building 80 x 200 feet, is noteworthy for the massive scale on which it has been equipped. Planers of 36, 48, and 60-inch capacity, lathes ranging from the smaller sizes up to 60-inch, all of Putnam Machine Co. make, and Niles-Bement-Pond boring mills up to 72-inch, are only a part of the equipment. The large machines occupy the greater part of the building, but one end is devoted to a shop of smaller tools and a commodious tool room is partly enclosed. A 20-ton traveling crane spans the main bay and a lighter crane the side bay.

The same completeness of equipment is apparent in the pattern shop, a thoroughly fireproof structure, 50 x 120 feet, adjacent to the machine shop. In addition to the usual run of patternmaking tools, the equipment includes a "Wadkin Woodworker," a machine of British manufacture rarely seen in American shops, though of remarkable efficiency in core box and shape work. In the pattern shop the tools are belt connected with a motor-driven shaft, but in the machine shop the individual motor drive is exclusively employed. Both the machine shop and pattern shop are equipped with the Sturtevant hot air heating system; on the visit of the writer they were comfortably warm, although it was early in the morning of the first day the system was in operation, and a sharp wind was blowing from the north.

Power and Water Plant.

The power house, which is sufficiently large to admit additional capacity, is equipped with two Robert Wetherill & Co. tandem compound condensing engines and two 150-kilowatt Westinghouse generators. The two boilers are Edgemoor, each 250 horsepower. The boiler house is connected by counterbalanced rising steel doors, with the coal pockets over which runs an elevated siding. The plant has its own water system, a Wetherill pumping engine of 1,500,000 gallons' capacity being a part of the power house equipment. The standpipe provides ample pressure on mains throughout the plant. There is absolutely no danger of fire, however, as the buildings are all of brick and steel construction, with slate roofs.

Concrete has also been generously employed.

Houses for Employes.

Owing to the fact that the plant is some little distance outside Bristol, and that even in the city accommodations for workmen are difficult to secure, the company has taken upon itself the housing problem. Regular streets have been graded through a plot convenient to the works, water mains have been installed and about 50 substantial brick houses have been erected. Thirty of these, arranged in terrace style, are of four rooms each; 16 are larger, having six rooms each, besides other advantages; and four are detached houses of good size. Besides these, several houses acquired with the site are now occupied by foremen. The location is such as to insure pure air, good water and thorough drainage; and, as Italian labor is chiefly employed, this little colony will go a long way toward settling the housing question.

The work of constructing this plant has required about a year and considerable is yet to be done on the No. 2 pipe foundry. No. 1 has just been completed, and the other departments have been in operation for some time. The two pipe foundries have a capacity of 350 tons of pipe daily, and the fact that there are four units renders it possible to specialize on sizes to a considerable extent.

Water and Rail Shipments.

In regard to shipping facilities, the site is extremely fortunate. A siding owned by the company runs from the Pennsylvania main line and encircles the plant. A new dock into the Delaware reaches 20 feet of water at low tide, thereby giving the best of water connections with all Atlantic coast points both for incoming and outgoing freight and securing an important advantage on pipe shipments for export.

MIXTURE FOR HYDRAULIC CYLINDERS.

By W. J. Keep

Question:—We have been requested to make a hydraulic cylinder for a car wheel press. The hydraulic pressure required ranges from 125 to 150 tons per square inch and the cylinder is not provided with brass bushings, but the inside is bored out to fit the ram. In this bored surface is cast an annular chamber to catch any water that may leak past the fitting of the ram and cylinder. The old cylinder proved defective in the chamber where the pressure is exerted on the ram. We have the following stock of pig iron: No. 1 hot blast—silicon, 0.75 per cent to 1.75 per cent; sulphur, 0.03 per cent; phosphorus, 0.70 per cent; manganese, 1 per cent. No. 2 cold blast—silicon, 1.21 per cent; sulphur, 0.19 per cent; phosphorus, 0.32 per cent; manganese, 0.26 per cent. Coke iron—silicon, 2.75 per cent; sulphur, 0.03 per cent; phosphorus, 0.40 to 0.70 per cent, and manganese, 0.30 to 1 per cent. We melted the following mixture in a cupola and cast one cylinder: Charcoal, cold blast, 600 pounds charcoal, hot blast, 3,000 pounds; engine scrap, 2,600 pounds. The weight of the cylinder was about 5,800 pounds, and we left the casting in the sand until cold. What is your opinion regarding this mixture?

Answer:—The casting should have contained about 1 per cent of silicon, 0.50 per cent of phosphorus, 0.07 per cent of sulphur, and 0.70 per cent of manganese. The approximate analysis of your pig iron varies too much to use in calculating a mixture of this kind. Your scrap should be considered as containing 1.50 per cent of silicon and 0.10 per cent of sulphur. You were safe in the mixture used owing to the low sulphur in the hot blast pig. I would suggest that you use 50 per cent of scrap, or the following mixture: Cold blast iron, 400 pounds; hot blast iron, 1,200 pounds; coke iron, 1,600 pounds; engine scrap, 3,000 pounds. Be careful to select the iron to keep the silicon below 1 per cent.

BUYING PIG IRON BY ANALYSIS.

The Pittsburg Foundrymen's Association, at its monthly meeting at the Hotel Duquesne, Nov. 2, expressed its judgment in favor of the buying of pig iron by analysis, a resolution to this effect being unanimously passed. This action preceded a thorough and interesting discussion of standard specifications for foundry pig iron, in which both foundrymen and furnacemen participated.

H. E. Field, of Mackintosh, Hemphill & Co., chairman of the committee of the American Foundrymen's Association, opened the subject. Mr. Field suggested the advisability of establishing a standard base analysis for foundry iron, calling for a fixed content of silicon and sulphur with a sliding scale arrangement which would allow a fluctuation in price by a certain constant, according to variations in the two elements.

The suggestion as to the working out of this sliding scale for iron analyzing above or below the base was to allow 25 cents from or to whatever price the contract might call for, according to the respective cases, for each unit of variation in the silicon or sulphur content. This arrangement would in no manner interfere with the market price of standard foundry iron at the time it was bought or during the life of the contract, this being as much a matter of individual settlement as at present. It would, however, provide a generally accepted and understood ratio for grades ranging according to analysis from the standard base. Mr. Field explained that his proposition was merely a tentative one, and that his committee was now at work upon the question of a standard specification, but had as yet reached no conclusions.

Walter Wood, of R. D. Wood & Co., Philadelphia, representing the committee of the American Association for Testing Materials, which is also working for a standard specification of pig iron, was present, and spoke upon the subject. He said the purpose of a standard specification in itself and outside of any contractual relations such as price arrangement, etc., was to afford the foundryman a clear recognition of an iron upon which he could base his calculations according to his individual needs as he knew them. Mr. Wood thought that the question could be handled in logical steps, first, whether buying by analysis is desirable, and second, what should be fixed as a standard analysis.

E. H. Williams, of the Perry Iron Co., Erie, Pa., spoke on the difficulties from the furnaceman's standpoint of always meeting ironclad specifications. This followed from a lack of uniformity in the manufacturing process beyond the control of the furnace, and resulting in the handling of the crude and varying materials, such as the ore, coke, limestone and even air. Mr. Williams believed that any standard specification should be broad enough to cover the variables in the manufacture for which the furnacemen were not responsible.

Mr. Mason, of the Midland Steel Co., Pittsburg, expressed his opinion that the fixing of any standard basis to be of value must be general in its scope, applying to furnacemen and foundrymen in all parts of the country. Other Pittsburg foundrymen and pig iron buyers who were present gave their views upon the subject. The sense of those present was that the standard base to be adopted should range from 1.75 to 2.25 silicon and 0.05 sulphur.

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Foundry Follow-Up System

The discussion of a practical method of following up orders through the foundry, presented elsewhere in this issue, directs attention to an important detail wherein many foundrymen are lax. It is true that the question of delivery was not a serious one during the last 12 months, as nearly all the casting plants were in position to make early shipments on account of the scarcity of orders. Yet in times of prosperity the adoption of the system outlined will prove beneficial to every foundry, inasmuch as delivery, made as promised, is a factor of as much importance to many buyers as the question of price. The plan is simple and does not involve an intricate card system with cross cuts that only too frequently are confusing. The distribution of work in the foundry to insure prompt attention and early completion is the first step, and the layout sheet for recording this operation is exceedingly simple. The daily work sheet is provided to let the molder know in a convenient way what he has to make. It obviates the necessity of pattern distribution throughout the day, and when work has been assigned each molder, the foreman can devote his time and attention to more serious problems throughout the plant. The third form, which completes the system, is known as the promise sheet. On this is entered the time when the work is to be finished and insures its delivery to the customer as promised. The accumulation of unfilled orders is entirely obviated, and the foreman is prevented from laying aside difficult patterns for molding at some future time when conditions might be more favorable than those existing when they are delivered to him. The advantages of the system are obvious to every foundryman, and its adoption will result in satisfied customers and a shop operated according to schedule.

Buying Pig Iron by Analysis

The purchase of pig iron by analysis is again provoking considerable discussion among foundrymen, and one local association has recently gone on record as favoring the buying of pig metal in this way. It is evident that, notwithstanding the efforts made by the American Foundrymen's Association to secure the adoption of its standard specifications governing iron contracts by the foundrymen of this country, in the bulk of orders placed with the furnaces, fracture alone is considered, and it is logical to assume that cupola charges in many shops are largely made up by rule of thumb methods instead of by chemical analysis. The revision of present specifications is desired by both the American Foundrymen's Association and the American Society for Testing Materials, and many meetings have been held which have been attended by both foundrymen and furnace operators. The question of buying by analysis is no longer involved. It is admitted that only in this way can the foundryman learn the exact nature of the material that he has purchased. The economy of this practice has also been proved beyond question, and the fracture theory was exploded many years ago. Whatever discussions the proposed revision of the present specifications should evoke, it would seem that they be limited to the proper protection of the foundrymen's interests in the way of rebates for inferior iron, and a suitable bonus should be provided on the other hand to be paid the furnace operators for an excess of silicon, and a maximum and minimum percentage of sulphur should also be named. Furnacemen generally contend that from a lack of uniformity in the manufacturing processes beyond control in the furnace, which result in a wide variation of the analyses of a day's production, that any standard specifications that should be adopted by the societies having the revision in hand, should be broad enough to cover the variables in manufacture for which they are not responsible. On the other hand, the foundrymen's interest must be protected. Purchasers of castings are becoming more exacting, and with a growing tendency towards decreased sectional weight and increased strength, it is absolutely essential that foundrymen have a definite knowledge of the nature of the metal which they are using.

Trade Outlook

During the past 30 days there has been a marked improvement in all branches of the foundry industry. There has also been a noteworthy revival in demand in the iron and steel trade, and the indications are that if this is maintained during the next few months the country will be on a normal basis, as far as iron production is concerned, early in the new year. Never before in the history of the iron and steel trade did production decline so

greatly from the previous year's record as in 1908, and the iron and steel output up to the present time has suffered a loss of nearly 40 per cent. However, it is refreshing to note that years of depression are generally followed by increased demand which carries production ahead of all previous high water marks, and as the iron trade is considered the barometer of general trade conditions, it is fair to assume that the foundry industry will benefit thereby. During the panic of 1894 only 6,657,388 tons of iron were made, but in the succeeding year production was increased to 9,446,308 tons—nearly 50 per cent. The depression of 1904 witnessed a decline to 16,497,033 tons from 18,009,252 in 1903. Yet in 1905 there was a marked revival of business, and pig iron production increased to 22,992,380 tons. Iron and steel masters, without undue optimism, freely predict that the loss of nearly 9,000,000 tons in the pig iron output during the present year, should at least be recovered in 1909, and if trade conditions measure up to their prophecy, the increase in demand will be nearly 40 per cent. Since July 1, pig iron production has shown a healthy monthly increase, and the October tonnage was 1,573,824 tons, as against 1,416,252 tons in September, an increase of 157,572 tons. During the past two weeks greater interest has been displayed in the pig iron market by foundrymen generally, and nearly everywhere the buying has been heavy. The indication of increased buying by the railroads is noticeable and includes almost everything from cars to track fasteners, and involves a heavy tonnage of steel and malleable castings. In the east, No. 2 standard foundry iron is held at $17, Philadelphia, and No. 2 southern is quoted at $15.75, Cincinnati. In the Chicago district, local No. 2 commands $16.50, and Lake Superior charcoal, $19.50. In the south, sales for the month easily aggregate 100,000 tons at prices based on $13 for standard No. 2.

PERSONAL.

Chas. H. Holt, foreman of the Wehrle Stove Works, Newark, O., has been appointed foreman of the foundry department of the Detroit Stove Works, Detroit.

George Tangye, one of the founders of the great engineering firm at Smethwick, England, has decided to present to Birmingham University, Birmingham, a group of most interesting relics, formerly belonging to James Watt, and now collected in the form of a group known as the Watt Museum. For a long time they found a resting place in Mr. Tangye's residence at Heathfield, Hansworths, England.

Arthur Knight, formerly superintendent of the foundry of the Manitoba Iron Works, Winnipeg, Manitoba, Can., has taken charge of the foundry of the Canadian Northern Railway Co. of that place.

John C. Pangborn, of the Thomas W. Pangborn Co., New York City, has been appointed one of the vice presidents of the Foundry Supply Association, to succeed his brother, Thomas W., resigned.

E. A. Pridmore, Chicago, has been appointed to the unexpired term of trustee of the Foundry Supply Association, held by his father, H. E. Pridmore, who died recently in Scotland.

G. L. Blunt, formerly superintendent of the Central Foundry Co.'s plant, Vincennes, Ind., has associated himself with the foundry department of the Moran Co., Seattle, Wash.

M. K. Weigel will sever his connection with the E. Killing's Molding Machine Works, Davenport, Iowa, on Jan. 1, and will engage in the foundry business at Wellington, Kansas.

R. E. Turnbull, well known in the molding machine trade throughout the central west, has again associated himself with Henry E. Pridmore, Chicago, for the exclusive sale of the molding machines manufactured by this concern.

N. O. Fleming, formerly connected with the Rust Boiler Co., Pittsburg, severed his connection with that concern on Nov. 15, to accept the position of general manager of the Union Foundry & Machine Co., Mansfield, O.

John E. O'Neil has been elected president and treasurer of the Davison Foundry Co., Chicago, to succeed O. H. Davison, who has retired from the company.

H. P. James, formerly electrical engineer of the Bryant Electric Co., has been placed in charge of the sales of the new line of push button specialties recently placed on the market by the Cutler-Hammer Mfg. Co., Milwaukee.

John Warrington, foreman of the plant of Archibald Kenrick & Son, Ltd., West Bromwich, Eng., was recently presented by the directors of this concern with a gold watch and guard, having an inscription recording the fact that he retired after 57 years of faithful service.

Frederick H. Leland, who has had a wide experience in shop organization and the development of cost accounting methods, has become associated with Marwick, Mitchell & Co., chartered accountants, 79 Wall street, New York. He will serve this concern in the capacity of industrial specialist.

OBITUARY.

Samuel DeVere Burr, managing editor of the *Metal Industry*, New York, died of appendicitis, at his home in Plainfield, N. J., Oct. 28, aged 53 years. Mr. Burr was for many years a writer on engineering and scientific subjects, and was well known among the journalists of the technical press. He secured the degree of civil engineer at Rutgers College, New Brunswick, N. J., in 1875, and subsequently received the degrees of A. B. and A. M. He was on the editorial staff of the *Scientific American* for six years, and for 16 years, from 1888 to 1903, was mechanical editor of *The Iron Age*. As an author, Mr. Burr is known for three works, "Bicycle Repairing," "Tunneling Under the Hudson," and "Rapid Transit in New York and Other Large Cities." He is survived by a widow, a married daughter and a son, Hudson C. Burr, at present a college student.

MIXTURE FOR LARGE CAST IRON BALLS.

By W. J. Keep

Question:—We recently filled an order for 2½ tons of cast iron balls for use in cement machines. The entire lot proved to be too brittle and was broken within 18 hours. In our mixture we used one-third stove plate and two-thirds of sash weight scrap. The balls are 5 inches in diameter and are apparently quite hard. What mixture should we use?

Answer:—Your mixture is entirely too high in sulphur. The stove plate scrap that you use undoubtedly contains a high percentage of sulphur, while the sulphur in the sash weights undoubtedly runs very high. You had better use old car wheels and if the castings prove satisfactory you might add stove plate and sash weight scrap to cheapen the mixture. The amount to be added should be carefully considered so that the entire mixture will not be damaged. Use 40 pounds of limestone for each ton of iron melted to remove the sulphur.

FOUNDRY & PATTERN SHOP EQUIPMENT

Tilting Crucible Furnace---Steel Shot for Sandblasting---Exhibit of Malleable Castings --- Patternmakers' Vise --- Centrifugal Air Compressors --- Molding Machines in Stove Foundries

A NEW tilting crucible furnace for melting the softer metals, manufactured by the Ideal Furnace Co., Scottdale, Pa., is shown in the accompanying illustrations. This furnace retains the good features of pit furnaces and combines with it the more modern method of pouring by tilting. The crucible is not removed from the fire and is always ready for fueling. Any required amount of charge can be poured from the crucible and the balance left in the furnace, which will hold its temperature for 1½ hours. No additional fuel is necessary during this time, as the air blast is shut off. By this method a heat or part of a heat may be held in the crucible until it is convenient to cast, with no bad effects such as over-heating or oxidation. As a large volume of air is required, a low pressure blower is used which tends to reduce oxidation.

The furnace is made of sheet steel and is composed of two sections, the main body and the locking ring. The body of the furnace which rests on two trunnions is lined with fire brick and carries its own grate bars and locking ring. This ring connects the furnace with the air supply base when in operation, and is locked to the body when pouring. The lining consists of 5-inch fire brick and the two special top bricks are made removable. The furnace has a capacity of 600 pounds, is 44 inches high over all and occupies a floor space 6 x 6 inches. The coke consumption is 40 pounds per 100 pounds of metal melted, and the air pressure required is one ounce. Tests show the loss in melting to be extremely light, and the metal can be poured in an hour and a half or less from the time of starting the fire.

FIG. 1—FURNACE UNDER BLAST

FIG. 2—OPERATING FEEDING FURNACE THROUGH HOPPER

The furnace under blast is shown in Fig. 1 and in position ready to tilt in Fig. 3. Fig. 2 shows the operator feeding the furnace through the hopper. This consists of an old crucible and by its use the metal is brought to a high heat and feeds itself into the lower crucible. In this way the surplus heat is utilized, resulting in a light fuel consumption. Light scrap can be fed into the crucible with a shovel and the hopper can be removed by means of a bar provided for this purpose. Fig. 4 shows the operator skimming the metal. The skimmer is an ordinary perforated cast iron ladle. A cross section of the furnace is shown in Fig. 5.

The crucibles are placed upon a block of graphite or on a brick about 6 inches high, which rests on the center grate made in one piece and fastened to the furnace body. The lip of the crucible extends into the wall of the lining at the pouring outlet and a wedge shaped brick opposite the lip holds the crucible in place.

CHILLED STEEL SHOT IN SAND BLAST WORK.

Attention is now being directed in the American foundry field to the use of chilled steel shot as a substitute for sand in the cleaning of castings by sand blast. This material is largely employed in the foundries of Great Britain and the continent, where the sand blast has been developed to a high state of efficiency, and many concerns employ it exclusively for their finer grades of work. These shot range from about the size of common bird shot down to almost a powder stage, and are tempered in such a way as to cut French burr, the hardest stone known in France, onyx, granite, etc. They do not break when coming into contact with the article to be cleaned; their cutting powers are retained for a long time, thus permitting of their repeated use. They can be used to advantage with any

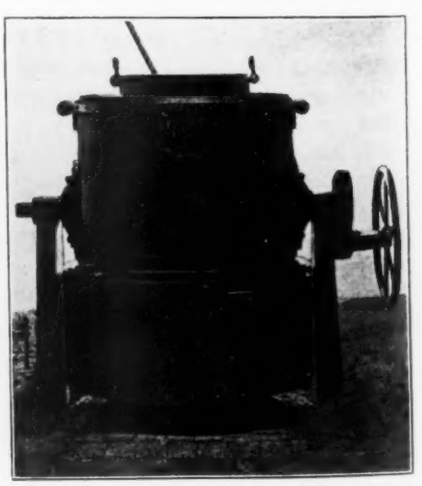


FIG. 3—BLAST OFF, FURNACE READY TO TILT

sand blast device operating with a pressure of 15 pounds. After they have been once used, it is necessary to sieve the shot, in the course of which process all foreign materials are removed. This elimination of dust

FIG. 4—SKIMMING THE METAL

and scale and constant employment of clean shot naturally produces very superior results.

The life of this chilled steel shot is extremely long. A Canadian concern has found their work economical and rapid in boring corundum rock, which had defied every previous attempt to core it with diamonds. Another statement is that "steel I-beams, old iron couplings, steel plates, etc., have been encountered and penetrated in soundings, as no substance seems to be able to resist the action of these tiny spheres of shot."

Sand blast work with this shot is remarkably rapid. With 15 feet of free air per minute, 1½ square feet of iron castings can be cleaned per minute at 15 pounds pressure, or 0.3 square feet of iron castings can be cleaned per minute at 15 pounds per square inch. With 34 cubic feet of free air per minute, 3 square feet and 0.6 square feet, respectively, can be cleaned per minute with 15 pounds pressure. The surfaces cleaned vary according to the number of cubic feet of free air, but the two examples cited give a fair idea of what can be done. The shot is imported by the Harrison Supply Co., 5 and 7 Dorchester avenue extension, Boston. This company has made an arrangement with the Tilghman-Brooksbank Sand Blast Co., Philadelphia, whereby the latter acquires exclusive selling rights of the material for sand blast purposes.

TRADE NOTES.

Matthew Addy & Co., Chicago, have been appointed exclusive selling agents for the product of the Williamson Furnace made by the Williamson Iron Co., Birmingham, Ala.

Hickman, Williams & Co., Chicago, have been appointed exclusive agents for the sale of the Bessie ferro-silicon made at New Straightsville, O. The territory covers all of the states west and south of Pennsylvania, exclusive of the city of Baltimore.

Robert A. Bruce, formerly with the Carnegie Steel Co., Pittsburg, has been appointed Pittsburg resident agent of Crocker Bros., 99 John street, New York City. The Pittsburg office of this concern will for the present be in connection with the offices of Reed F. Blair & Co., Frick building.

The Northern Engineering Works, Detroit, has installed a No. 30 Newton cupola in the foundry department of the Rensselaer Polytechnic Institute, Troy, N. Y.

Ed. E. Squier & Co., 309 Equitable building, St. Louis, Mo., miners and shippers of molding sand of all kinds, have established a Chicago branch and are represented in that city by Burnell & Hammer, room 516, 112 So. Clark street.

The S. Obermayer Co., Cincinnati, manufacturer of foundry supplies and equipment, is sending a souvenir postal to the foundry trade showing its Cincinnati plant.

The American Compressor & Pump Co., 26 Cortlandt street, New York City, has been organized to engage in the manufacture of air and gas compressors, air receivers, high duty vacuum pumps, pneumatic specialties, etc. The company's plant is located in Baltimore, Md., and is in charge of Alex. Slaysman Jr. Frederick B. Vail, formerly general sales agent of the American Air Compressor Works, has been placed in charge of the sales department.

The S. Obermayer Co., Cincinnati, O., has just issued the fourth edition of its general catalog No. 40. This issue contains a number of additions and corrections and its 369 pages contain much valuable information for foundrymen generally.

The Independent Pneumatic Tool Co., Chicago, manufacturer of pneumatic tools and appliances, reports that its sales during October showed an increase of approximately 25 per cent over any month during the present year.

The Ideal Furnace Co., Scottdale,

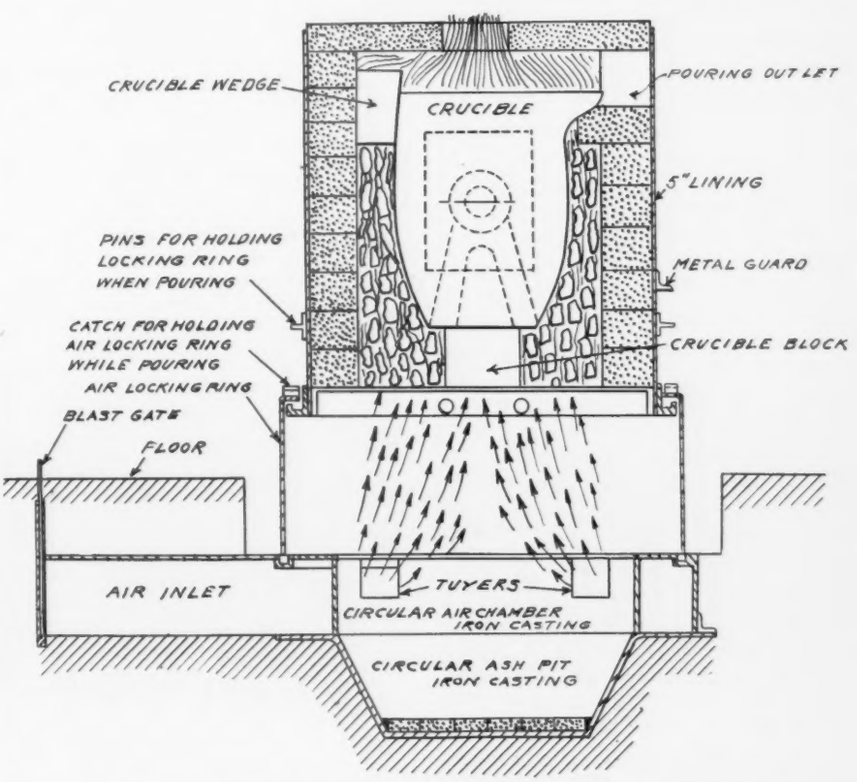


FIG. 5—CROSS SECTION OF IDEAL TILTING CRUCIBLE FURNACE

FIG. 1—EXHIBIT OF MALLEABLE CASTINGS AT NATIONAL ASSOCIATION OF AGRICULTURAL IMPLEMENT AND VEHICLE MANUFACTURERS' CONVENTION

Pa., recently organized, will build a tilting crucible furnace for melting the softer metals. P. J. Sweeney, president of the company, was associated with the Rockwell Engineering Co., New York, for six years, and W. J. Holzapfel, secretary of this concern, and inventor of the furnace, is superintendent of the Crescent Mfg. Co., Scottdale, and has had a wide experience in brass foundry work.

Owing to the rapidly growing demand for its rotary pressure blowers and exhausters, the Wilbraham-Green Blower Co., Philadelphia, has been compelled to seek larger quarters where better manufacturing facilities would be provided. A site was purchased about Aug. 1 on the Philadelphia & Reading railway in Pottstown, Pa., upon which a machine shop 85 x 200 feet has since been erected. The building is of brick and steel construction and has a temporary end which can be easily removed for further extensions. The shop is commanded by a 10-ton Shaw electric crane, having a 40-foot span and commands the entire length of the middle bay, in which the heavy tools are located. At one end of the shop the large blowers will be erected. The smaller tools are located in the two side bays, all of the machinery being located on the ground floor. A railroad siding extends through the erecting end of the shop at right angles to the building. The installation of machinery has been practically completed and the plant is now in successful operation.

AN INTERESTING EXHIBIT OF MALLEABLE CASTINGS.

One of the most interesting features presented at the recent convention of the National Association of Agricultural Implement and Vehicle Manufacturers at Columbus, O., was the joint exhibit of the Ohio Malleable Iron Co., and the Jeffrey Mfg. Co., of that city.

This contained a very fine display of malleable detachable chains, including many specimens which illustrated the substantial progress recently made by the former company in the refinement and production of malleable iron. The extremely malleable and ductile qualities and high tensile strength in the iron, were shown by chain links bent double and distorted in every conceivable form, by impact, torsion, bending and tensile strains, without the occurrence of fractures.

Two very small chains were also displayed to illustrate the molding qualities of the iron resulting from the high degree of fluidity obtained. The links composing the larger of these chains were ⅜ inch pitch, 5/16 inch wide, with a maximum area in cross section of 1/16 inch, while those of the smaller were 5/32 inch wide, 3/16 inch pitch, with a maximum cross sectional area of only 1/32 inch. As the sectional area of a conduit, through which iron will run, has commonly been limited to about 3/32 inch, it will be seen that the former of these chains has a section ½ and the latter 9/10 smaller than the smallest heretofore produced, for which achievement much credit is also due to the high degree of skill exerted in molding.

The larger of these chains is designated as "Ohio Special 0.08," and the smaller as "Ohio Special 0.008." Lengths of both were shown in suspension from scales, the 0.08 sustaining a weight of 75 pounds, and the 0.008 of 15 pounds. The pull on the former was increased by hand to 130 pounds, without visible effect on the links, and as these were assembled as

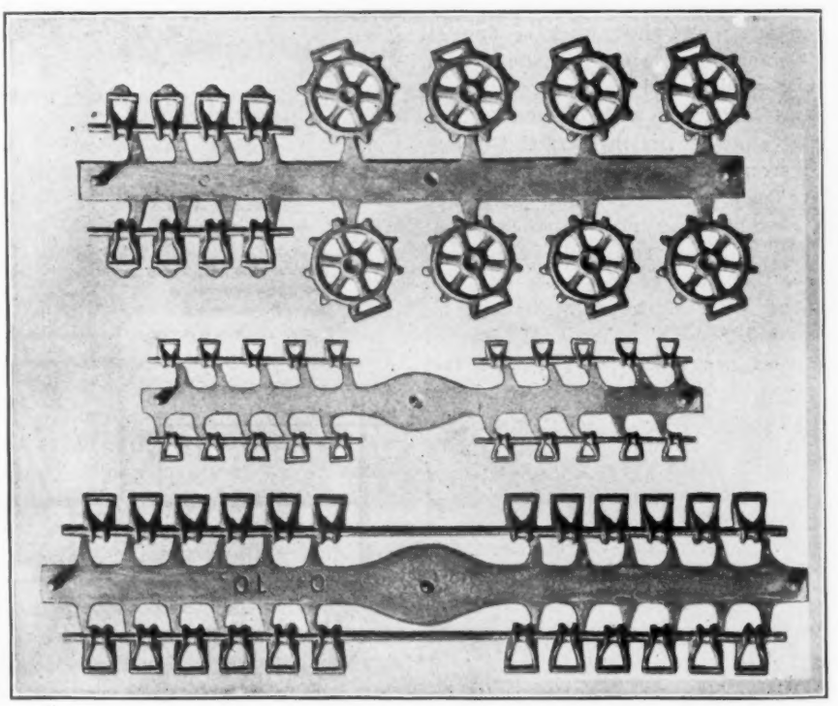


FIG. 2—METHOD OF GATING PATTERNS FOR MALLEABLE CASTINGS

made, without the usual tests to develop weak or defective parts, it may be safely assumed that with such parts eliminated, the larger chain would develop a safe working strength of about 30 pounds, or approximately one-half that of the ordinary commercial No. 25, which has four times its maximum area in cross section.

To demonstrate the accuracy of pitch and uniformity in shape of the links composing these chains, running tests were also made. In one case a small rotary fan, and in another a group of American flags was caused to rotate. Both were driven from electric motors, the former by a single strand of 0.08 chain, and the latter by two strands of 0.08 and one strand of 0.008 chain, three reductions being made. The chain speed was high in both cases, and its operation was very smooth and quiet.

The accompanying illustrations show a portion of the exhibit. The gated patterns shown were used for making the parts of souvenirs which were distributed at the convention.

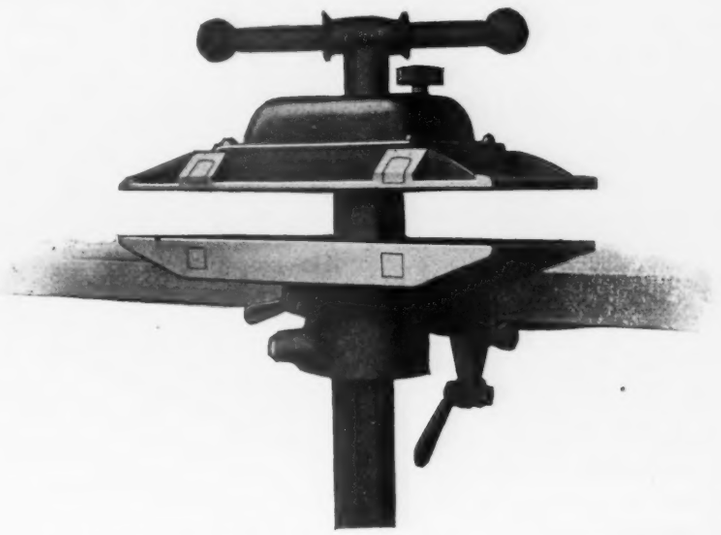
It is stated by the companies that no special heat or composition of iron was resorted to in producing these chains, nor in fact any of the specimen links on exhibition, but that all were made in the ordinary way from regular heats and correspond in all respects to the daily run of the foundry. The Jeffrey Mfg. Co. is represented as the sole distributor of all chains manufactured by the Ohio Malleable Iron Co.

A UNIVERSAL WOOD WORKERS' AND PATTERNMAKERS' VISE.

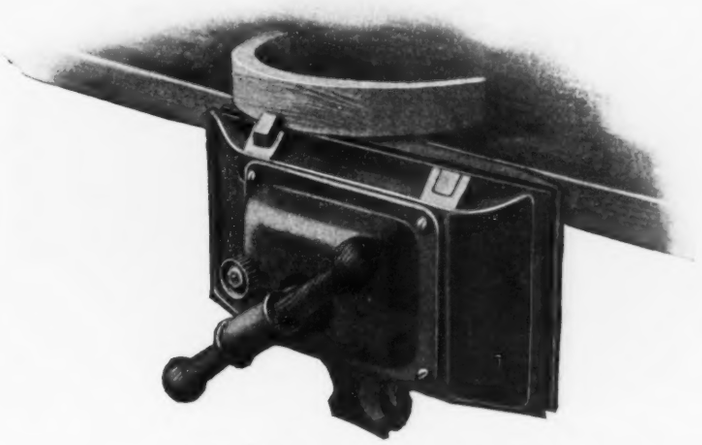
The accompanying illustrations show a new universal wood workers' and patternmakers' vise placed on the market by the G. M. Yost Mfg. Co., Meadville, Pa. The vise can be placed in a great variety of positions, some of which are shown herewith. It has, practically speaking, six pairs of jaws, four of which are formed by the sides of the vise, the other two pairs being projections from the body of the main jaw, as shown. By means of the various combinations of jaws, practically any kind of irregular work may be gripped in the vise.

The hub is cast solid on the back jaw, and a sleeve fits over it, so that the vise can be locked in any position through 360 degrees which may be required, and in such manner that there is no shake or lost motion. In addition, the vise can be swung up through an angle of 90 degrees, as shown in the illustration, thus allowing the work to be put in any position desired. The hinge or plate for fastening the vise to bench is so constructed that it is unnecessary to cut away any part of the bench in mounting the vise. The rack bar for holding the vise in its vertical position is held by friction, and is of simple construction.

The jaws are 8 inches wide and 16 inches long. The depth from the face of the jaw to the top of the beam is 3½ inches.



YOST PATTERNMAKER'S VISE SWUNG UP PARALLEL TO BENCH.



THE YOST PATTERNMAKER'S VISE

COMPOUND FOR REPAIRING IRON AND STEEL.

The H. W. Johns-Manville Co., New York, has placed on the market a new metallic compound under the trade name of "Leak-No," which is intended for repairing iron and steel castings. Leak-No is a chemical compound resembling powdered iron and when mixed with water and applied like putty to defects in iron or steel articles, it is claimed that it metallizes and becomes a permanent part of the casting to which it applies. It furthermore has a metallic luster when hard. It also will withstand the pressure of oil, steam, gas, air, ammonia or water, and will withstand any heat or chemicals that iron will withstand. The manufacturers have issued a neat booklet describing this material and giving directions for its use.

The Brown Specialty Machinery Co., Chicago, manufacturer of the Hammer core machine, has issued a neat little booklet entitled "Screw Machines vs. Plunger Machines." It contains a discussion of the relative merits of these two types of machines for making cores.

The Northern Engineering Works, Detroit, has made a large installation of electric traveling cranes in the plant of the Penn American Plate Glass Co., Alexandria, Ind. It consists of five three-motor cranes, four having a span of 65 feet and one of 30 feet.

A NEW LINE OF CENTRIFUGAL AIR COMPRESSORS.

Owing to the great demand for moderate pressure air compressors for industrial air blast and exhauster service, the General Electric Co., Schenectady, N. Y., has carried out during the past few years a series of exhaustive experiments on the centrifugal type and is now prepared to furnish a line of standard centrifugal air compressors with pressures rated from 0.88 to 4 pounds per square inch, and in capacities from 750 to 10,000 cubic feet of free air per minute.

The centrifugal air compressor consists essentially of a rotating impeller surrounded by a suitable casing with an intake opening at the center and a discharge opening at the circumference. In appearance and in operation it is similar to the well-known centrifugal pump, the efficiency depending largely upon the design of the

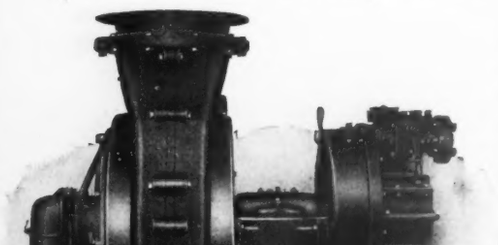


FIG. 1—TURBINE AIR COMPRESSOR

impeller and casing and on the proper shaping of these parts. These machines are of very sturdy construction and will operate under adverse conditions with a very low cost for maintenance. A successful compressor of this type necessitates a thoroughly reliable high speed driver. For this purpose standard turbines have been used in many cases and standard turbo-generators have been utilized as direct current motor drivers with but slight change. Compressors driven by induction motors are also available. Figs. 1 and 2 show the representative types of turbine and motor driven compressors.

These motors are of construction similar to the generators in turbo-generator sets. Commutating poles and shrunk-ring commutators are used so that sparkless commutating is insured. Each direct current motor is furnished with a suitable rheostat, so that adjustment of pressure can be obtained by changing the speed. The turbines used for these sets are of the Curtis type. Under the same conditions of service the steam consumption compares favorably with that of the best reciprocating engines. Slight speed variations can be readily made so that changes in pressure are easily obtained. Turbine driven sets can be furnished for non-condensing operation and sets above 50 horsepower can be furnished to operate condensing, if desired. These turbines are adapted for steam pressures from 100 to 175 pounds. The induction motors are furnished with the well-known squirrel cage type of rotor. Since the speed of this type of motor cannot be varied, care must be taken to specify a pressure sufficiently high to cover the operating requirements, because at constant speed the pressure cannot be varied without altering the design of the impeller.

All compressors should be furnished with a blast gate located in the discharge main. This gate consists of a simple butterfly valve which prevents the compressor from becoming loaded during the starting period. It also cuts off the discharge main from the opening through the compressor shell to the atmosphere when the set is not in use.

As in the case of centrifugal pumps, the pressure depends on the peripheral velocity or rim speed of the impeller. Increased pressure can be obtained by increasing the speed. The volume of free air is, however, limited by the capacity of the driver, and hence must be reduced proportionately to the increase in pressure, otherwise the driver might become overloaded.

The pressure in the mains leading from the compressor is entirely free from pulsation and practically constant for all volume within the rated capacity of the compressor.

For foundry cupola service the direct current motors can be compound wound so as to automatically increase the speed should the volume of air delivered decrease, thus increasing the pressure of the air and preventing undue reduction of flow of air

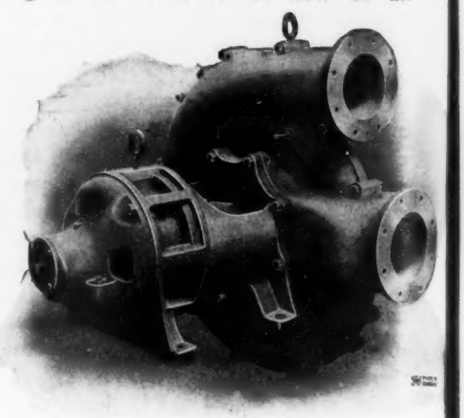


FIG. 2—MOTOR DRIVEN AIR COMPRESSOR

through the cupola when it chokes up. Further adjustments of pressure can be made by changing the speed of the motor by means of the field rheostat. Similar results are obtained for the turbine driven sets by means of a compensating governor. This feature is not required in all foundries though it is considered essential in some.

Since the pressure developed is practically constant from no load to 25 per cent overload, as is strikingly shown in Fig. 3, these compressors are well adapted for constant pressure work as in gas or oil furnace service. For this service one large compressor may be installed in a central location with distribution mains running to the different furnaces, such an installation being preferred to one in which a number of small blowers are located in various places. For ordinary gas or oil furnaces the rated pressure of 1.7 pounds should be sufficient, although for furnaces requiring a concentrated or positively directed jet, 2.7 pounds rated pressure may be desirable.

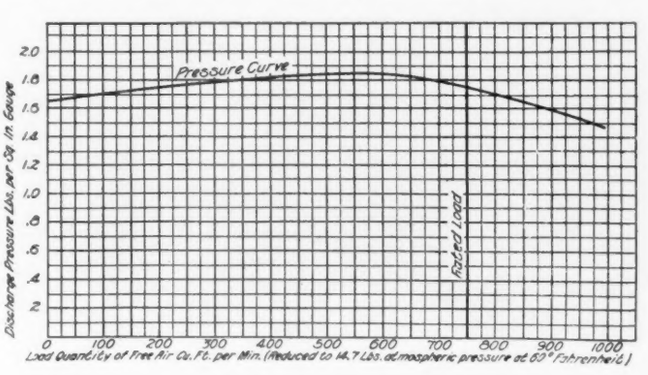


FIG. 3—CHART SHOWING PRESSURE CURVE

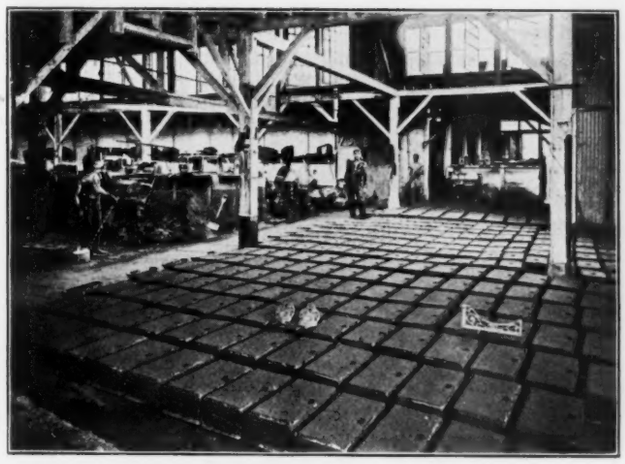


FIG. 1—TWO FLOORS OF MOLDS. TEA SHELVES AT THE LEFT AND BRACKETS AT THE RIGHT

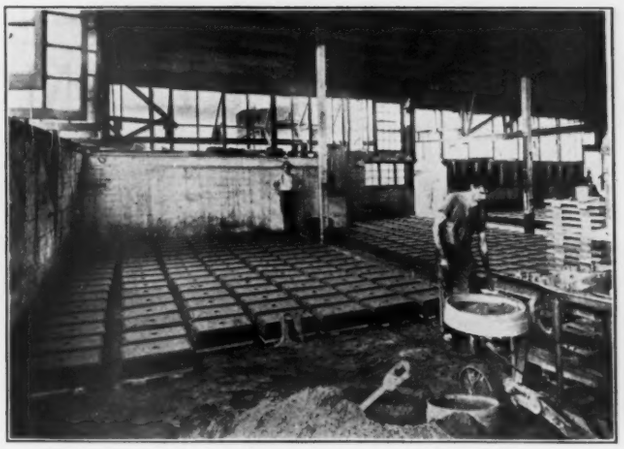


FIG. 2—FLOOR OF CUT, STOVE CENTER MOLDS, SHOWING MACHINE AT THE RIGHT

MODERN MOLDING MACHINES IN STOVE FOUNDRIES.

Stove foundrymen are constantly displaying a greater appreciation of the value of the molding machine in the production of their thin castings, and in many plants throughout the country this equipment is more than doubling the daily output.

The accompanying illustrations are interior views of one of the foundries operated by the Buck's Stove & Range Co., St. Louis. They show the floors filled with molds, the output of one man and one machine each, from 7 a. m. to 2 p. m. This plant has a large equipment of Modern molding machines installed by the Arcade Mfg. Co., Freeport, Ill., on which many intricate sections are now made more satisfactorily and with greater rapidity than is possible by hand work.

Two floors on which tea shelves, shown at the left, and brackets at the right, are molded, are illustrated in Fig. 1. The flasks for the tea shelf molds are 11 x 19 inches and the daily output of one molder, operating one machine without assistance, is about 180 molds. The bracket molds are 13 x 21 inches and the daily output averages 180.

In Fig. 2 is shown a modern machine operating on cut, stove centers. The molder has not yet completed his day's work, as the photograph was made before the noon hour.

A floor of molds containing two stove covers each, are shown in Fig. 3. The flasks are 11 x 22 inches and one man puts up on an average 220 molds daily. The record for this floor is 243 molds.

A floor, partly poured off, on which stove legs are molded is shown in Fig. 4. The flasks are 12 x 22 inches and two legs are contained in each mold. The average output for one man is 180 molds. By hand work, none of these floors averaged more than 80 molds daily.

Each molder pours off his work, the iron being delivered to his floor, the castings being shaken out by a gang employed for this purpose. While the sand is tempered at night, the molders cut it over in the morning before they begin to operate their machines.

BRASS MIXTURE FOR SCALE BEAMS.

Question:—Will you kindly give me a good mixture for yellow brass scale beams, and also describe a method of pouring.

Answer:—A good mixture for scale beams should contain copper, 7 pounds; zinc, 3 pounds; tin, ¼ pound; lead, 2 ounces. The metal will flare considerably while pouring, but it will not be necessary to pour these castings with the metal running hot. When boiling, tongs or skimming iron inserted into the bath will vibrate perceptibly. To cool the metal a gate should be added and great care should be exercised to have it dry. When the surface of the metal can just be seen, the mold should be poured, rushing the metal in fast enough to keep the pouring head full, which prevents the oxide from entering into the mold and insures clean castings. The addition of four ounces of aluminum to 100 pounds of this alloy will greatly improve its casting qualities. K. K.

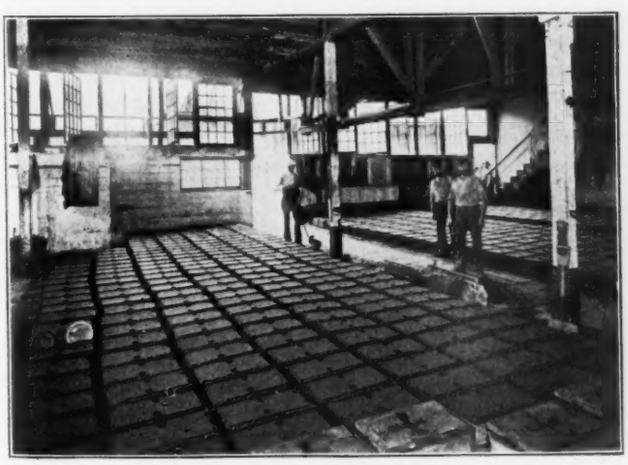


FIG. 3—FLOOR OF STOVE COVER MOLDS

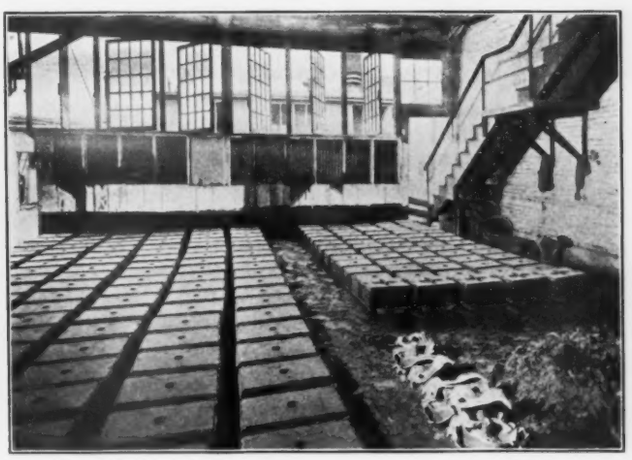


FIG. 4—FLOOR OF STOVE LEG MOLDS PARTLY POURED OFF

STOVE PLATE MOLDING MACHINES

Report of the committee representing stove founders favoring the adoption of molding machines and other labor-saving equipment

AT THE meeting of the Stove Founders' National Defense Association, held in New York City, Nov. 18 and 19, the committee appointed May 12 to investigate the adaptability of molding machines for stove plate work, submitted an exhaustive report. The committee consisted of Grange Sard, Bartlett M. Shaw, Philip Will, Lazard Kahn and Fred Sattler. It was instructed to secure such information regarding labor saving machinery and devices as would enable the stove founders to estimate for themselves the possibilities of economy to be secured by means of machinery and devices in use or available and the conditions most favorable to their successful operation.

The committee pursued its investigation by correspondence, and personal visits to the following points: Toronto, Philadelphia, Cleveland, Detroit, Dowagiac, Mich.; Chicago, Freeport, Ill.; St. Louis, Newark, N. J.; Syracuse and Utica, N. Y.

Reply postal cards were also sent to 227 stove manufacturers in the United States, asking what kinds of labor saving machinery was used in their shops, and 121 replies were received. Of this number, 74 replied that they used no machinery whatever; molding machines were used in 51 plants; polishing machines in 49; polishing mills in 34; stove blacking machines in 31; sand cutting machines in six; sand mixing machines in seven, and sand milling machines in 10 foundries.

Questions Asked by the Committee.

In discussing the conditions most favorable to the greatest success with molding machines, the committee made the following summary:

Patterns of a size and shape that can be successfully made on machines now on the market.

Long runs on the same pattern and co-operation of operatives in securing maximum output from the machines.

To ascertain how well conditions in the stove foundry meet these requirements, the committee submitted a number of questions covering these conditions as follows:

What stove patterns or similar patterns are successfully molded on machines or devices now on the market?

What type of machine is best adapted for making different classes of work, and what range of work will that machine make?

Having determined that a pattern could be successfully made on the machine, the committee ascertained how many pieces must be made per year to make it pay to use the machine. The cost of the machine was also secured, as well as the expense of rigging the patterns.

Another question asked was in regard to the output of the machines and the reduction in molding cost.

Other questions submitted follow:

Is the change from one pattern to another easily and quickly made, so that castings can be made as required and not piled in large quantities in a store house?

Are any new items of cost of, say a reduced molding price to be considered such as cost of repairs to machinery, extra labor in carrying iron and pouring off, extra labor in shaking out molds and cutting over sand?

Labor.

The question of labor was also considered to ascertain what class gave the best results on molding machines. The continued observations led the committee to conclude that there are few, if any stove patterns, that cannot be made on a machine, or some form of device or rig that reduces the requirements for molding skill to the point where labor of ordinary intelligence may be taught in a short time to produce castings in equal or increased quantity, and of equal or better quality than are now made by the average stove plate molder, and nearer to pattern weight.

Some of the work now being made on machines in shops visited include circular top racks, straight oven burners, gas top stoves measuring up to 30 x 50 inches, oven doors, etc., for gas stoves; ranges or the parts of ranges made include duplex grates, fire box linings, doors, short and cut centers, open sides, water backs, etc. Oak stoves, or parts of oak stoves—legs, bases, doors, tops, grate rings, grates, fire pots, etc. Sections of steel ranges—oven door frames, pouch fronts, high closet brackets, oven door springs, caps, etc.

Molding Machines.

Several pages of the report are devoted to a careful discussion of the various types of molding machines used on stove plate work. These include squeezers, both of the ordinary type and those used with duplex match plates; stripping plate machines, automatic molding machines, multiple molding machines, hand ramming stripping plate machines, rock-over drop table machines, gravity molding machines, jolt ramming machines, jolt ramming and pressing machines, as well as a simple match plate, together with a hinge device which the committee reported upon favorably.

In reviewing the different classes of molding machines and devices in use on stove plate work and the character of work which they are best designed to handle, it was found that small work that can be made in snap flasks up to 400 square inches in area has the widest range of choice of apparatus, and which reduces the requirements for molding skill and the hand work performed by molders to a minimum. On work of larger area, the demands upon the skill of the molder are greater.

One of the stove manufacturers visited expressed the opinion that all stove plate castings may be made upon the machines, provided the stove manufacturer will remove all his prejudice and that of his organization, and that the latter will co-operate with him in obtaining this result.

Printing Back.

Regarding printing back patterns, the committee made the following observations:

The printing back of stove plate castings has been another stumbling block to the molding machine man, and so far as it may be done away with, the introduction of the machine may be made simpler, as in printing back, an absolutely perfect alignment of the pattern with its previous position is necessary. This is very difficult where there is the slightest wear upon the guides. This wearing of the guides in the dusty stove plate shop is almost impossible to avoid. The suggestion, therefore, that, through a

proper preparation and treatment of the molding sand, the necessity for printing back in order to secure a smooth face casting may be done away with, harbors promise of emancipation from this requirement and the removal of a serious obstacle to progress in the use of machines for stove plate. The committee, in fact, before they completed their investigations, found this suggestion carried out to a limited extent in actual practice, castings of a perfectly smooth and satisfactory finish being produced without printing back. In this case no facing or parting sand was used in the molds, the castings being merely well milled in exhaust mills.

Cost of Patterns and Machines.

With regard to the duplex match plate squeezer type machine, where a set of patterns cost from $22.00 to $60.00, it was learned that it generally required the making of 800 to 1,000 molds to have it pay to rig up the patterns.

The committee reported that a simple type of hand molding press without pneumatic rapper, may be purchased for about $40, while other types of hand presses which have the roll-over feature and mechanical hand draft may be purchased for $200 to $300 each.

The more elaborate power machines cost from $400 upwards. The cost of pattern plates on the machines, ready for use, varies from $10 to $60 each, according to the material used, size and shape of patterns, and style of pattern plates.

Reduction in Molding Cost.

The reduction in molding cost will vary from 30 per cent to 50 per cent, but this is only a general statement and wide variations were found. The committee noted cases in which the reduction from the bench price amounted to little more than 20 per cent while in other instances the reduction was almost two-thirds of the floor or bench price.

In foundries where equipment and methods are poor, well adapted machines and pattern equipment have the opportunity for realizing greater savings than in shops where the floor and bench equipment is first class, and the maximum output, according to the methods now in use is already secured.

Change of Patterns.

Nearly all machines and certainly all those that would be recommended for use in the stove foundry, are designed to take different patterns and in many cases a wide range of shapes and sizes. The change from one pattern to another can be effected by those somewhat accustomed to the operation in from a few minutes to an hour. Without doubt it is economy to run the same pattern for not less than a day at a time and change patterns outside of molding hours. Where the double faced match plate is used the change is so readily made as to be of itself a matter of no moment. Where changes must be made in molding hours the cost of molding will of course be higher.

Costs Offsetting Reduced Molding Prices.

Some of the items of cost offsetting reduced molding prices are the extra help in handling iron, flasks and sand; cost of making changes of patterns; the depreciation of and repairs to machinery.

On very large floors and where the iron is brought to the floor it was found that two hours' help of a laborer in shifting weights, strippers and in shaking out is all the help that is required.

The manner of figuring depreciation on machinery varies so widely that it is deemed sufficient to simply call attention to this item, leaving it to each manufacturer to figure in his own way.

The cost of making patterns for the machine may be varied in accordance with the number of pieces to be made and with the type of machine used. The cost of distributing iron to the floors from the cupola is an item for which we are not prepared to give figures. It will vary in accordance with the size, layout and facilities of the shop. It was found that in some foundries the practice of delivering iron to the molders' floors was already established and in such cases, of course, this would not form an item of additional cost. The use of the trolley system for carrying iron, where this becomes a separate item of expense to the manufacturer, is recommended.

Conclusion.

Some of the conclusions formed by the committee after the study of molding machines in the stove industry are in brief as follows:

That the stove industry is far behind others in the employment of labor saving machinery and devices.

Molding machines are successfully used in stove foundries to reduce molding cost.

Those institutions that are making the most use of the machines are also those that are most rapidly adding to their equipment.

There is at least a reasonable hope that the necessity for printing back may be done away with where exhaust mills are in use. (In this connection we suggest that the stove manufacturer visit his molding shop and find out how much of the work is printed back which he pays the molder to print back.)

That all stove patterns can be molded with some form of machine or device already in use.

It is merely a question of the cost of patterns for the machine and the number of pieces to be made whether or not it will pay to mold the piece in question by machine. For bench work the number so required to be made to make machine molding profitable is about 1,000 molds for the more expensive pattern rig, and a correspondingly small number for the less expensive rig.

It requires a smaller number of large pieces to be made to pay for new pattern equipment, since the saving per piece is larger in proportion to cost of pattern than in the case of small pieces.

Through the use of these practically indestructible pattern plates in place of loose iron patterns, the cost of maintaining patterns in repair is reduced and the necessity of preserving and caring for duplicate sets of patterns in wood or iron obviated.

The best results may be obtained from a system of specialized labor which allows the machine operator to devote himself exclusively to molding and pouring, that is, allows the machine operator to perform only such work besides actual molding which will still make it possible to hold him responsible for good castings. Carrying iron, shifting weights and strippers, shaking out and if possible, cutting over sand should be performed by common labor—machine operators to be. This suggests the employment of surface or overhead carriers as labor saving devices.

A saving of about five per cent of iron in machine over hand molded castings seems not unreasonable to expect. An incidental effect on factory economy is suggested by the report of a case where a reduction in the cost of grinding and mounting small cast ranges was secured, after the castings were molded by machinery.

The manner, most apt to be successful, of making molding machine installation is:

1. Determine that you have enough

patterns of which the necessary number of molds are to be made to keep a number of machines busy.

2. See that your organization from manager to machine operator is prepared to back the machine with intelligence, energy and enthusiasm.

3. Select carefully the make of machine best suited to your work. Start with not less than two machines and let all be of the same make.

4. After having begun right see that your installation continues to work right.

The increased use of molding machinery will result in increased standardization of parts and reduction in the variety of patterns.

Automatic Polishing Machinery.

The committee made the following report on automatic stove plate polishing machines:

"In this department of our investigation our first inquiry was understood in a great many cases as referring to the ordinary hand polishing lathes, so that before this misunderstanding was cleared up the number of users of automatic polishing machinery dwindled considerably. We have, however, received enough complete and reliable reports to show what may be accomplished with the help of the automatic polishing machine.

"We found both eight and 10-arm machines in use, the latter being of more recent design. The 10-arm machines are recommended as having a larger capacity and costing little, if any, more to operate.

"The cost of the machine is: Eight-arm, $2,500.00; 10-arm, $3,000.00.

"The average cost of fallow-boards is reported at $1.85 to $4.50.

"The number of fallow-boards required depends upon the variety of work to be polished, the maximum number, of course, being required where the variety is greatest, and the number of each piece to be polished smallest. Conversely, the number required is least where the variety is smallest, and the number of each piece to be polished maximum.

"The machine requires about 15 horsepower to drive it.

"Every report we have received, except one, places the grade of work equal to hand-work, some even going so far as to claim superiority for it on work of large size. Certainly the work that the committee saw turned out by the machine left nothing to criticize.

"Castings to be polished on the machine must be flat or oval. In proportion as a piece is very large or bulging the work of touching up such parts of the area to be polished as are not reached by the machine wheels is increased, and the approach to the cost of polishing by hand the nearest. On the other hand, in proportion as the work is flat and finished complete by the machine, the work of touching up is reduced and the saving greater. Further, large, heavy work on which a premium is sometimes paid to polishers on account of its size and difficulty of handling, is as easily handled by the machine as small work, and the saving in this class of work is proportionately the greatest. The machines are usually designed to do working running from 24 to 30 inches in width. to any length required.

"The number of men attendant upon the machine is variously reported from one laborer at $1.50 to $2.00 per day, to two union polishers at $4.00 per day, and part time for the third at $4.00 per day. The number of men required to touch up work after the machine varies from one to four. They are sometimes journeymen, sometimes apprentices; generally paid by the day but in some cases working piece work. This number will vary with the amount of work turned out by the machine."

Cost of Operation.

The cost of operation was reported upon as follows:

"The total cost of operation runs from $4.25 to $17.50 per day. These figures include all costs of operation and keeping machine and fallow-boards in repair. The cost of operation, however, is almost entirely labor cost and the largest part of this cost is for touching up after the machine. We find, therefore, that in cases where the total cost of operation is greatest, the amount of work put through is greatest, and the savings both in amount and in percentage of hand-polishing prices are greatest.

"In round numbers, the output of the machine varies from 200 to 400 pieces per day and from $7.00 to $43.00 in terms of hand polishing prices. The corresponding daily savings over hand polishing are $3.00 to $26.00. The percentage reduction from hand-polishing cost runs from about 25 to 80.

Conclusions.

"The machine may be profitably operated on the work that requires from four to ten polishers to do, provided that the work is of a character suited to the machine.

"Greatest savings are made by pushing the machine to its full capacity.

"Two machines can be operated more cheaply than one, and three more cheaply than two.

"Best results are secured by employing unskilled help and breaking it in to run the machine and do the touching up after the machine.

"The flatter and larger the work, the better is it adapted to the machine; the more round and crooked, the less it is adapted to the machine.

Sand Cutting Machinery

"There is now on the market a machine designed for cutting over sand heaps in the form in which they are found in the stove foundry. This machine is mounted on four wheels, two to run on each side of the sand heap. The sand cutting wheel roughly resembling a pair of ventilating fans mounted face to face, is mounted on a vertically-movable shaft, which may be raised to clear the wheel of the sand, or in action dropped until the revolving blades just clear the floor. This machine, originally designed to be driven by an electric motor, is now operated by a gasoline engine. Both the sand cutting wheel and rear wheels are driven by means of gears and chains connected to the motor or engine shaft.

"This machine undoubtedly does good work and might become an important unit in a complete scheme for the subdivision of labor in the foundry, particularly when molding machines are used and it is desired to have the molding machine operator devote all of his time to molding.

Sand Mixing Machinery.

"The inquiry regarding sand mixing machinery was prompted by a suggestion made to the committee to the effect that certain kinds of sands properly mixed and worked over by machinery and used as molding sand might obviate the necessity of printing back in order to produce smooth faced castings. It was desired to learn if any manufacturers had made an effort to put this theory to the test. So far as the committee was able to ascertain, however, nothing of the kind has been done. The only sand mixing machinery found in use was that commonly used for mixing core sand in foundries where large amounts of this material are handled."

TRADE PUBLICATIONS.

THERMIT.—The Goldschmidt Thermit Co., 90 West street, New York City, has issued a 28-page pamphlet entitled "Applications of Thermit in Foundry Practice." The method of using this material for reviving dull iron or steel, melting scrap, etc., is described at length, and other uses are considered, such as preventing piping in steel ingots, and the use of thermit for keeping the risers open. The use of titanium thermit cans, as well as the chemical reaction secured, are also described. The pamphlet also contains an extract of a report on the methods used to avoid piping in steel ingots as applied in the Hungarian Government Steel Foundries.

STEEL FOUNDRY FURNITURE.—The Kilbourne & Jacobs Mfg. Co., Columbus, has issued a 16-page pamphlet describing its line of steel factory equipment. This includes ore baskets, ladle bowls, tote boxes, steel barrels, barrels and trucks, pans, etc. The ladle bowl is made of sheet steel and is provided with a corrugation to hold it in the shank. Besides being much lighter than the ordinary cast iron ladle bowl, it is much more durable and not so easily broken. These bowls are 7 inches deep and 8¾ inches in diameter.

SHAKERS AND RIVETERS.—The Hanna Engineering Works, Chicago, devotes catalog No. 3 to a description of its full line of hydraulic riveters. This concern also manufactures a complete line of foundry shakers and riddles, including a screen shaker operated by either steam or electricity, stationary post shakers, and a revolving dumping riddle electrically operated.

CORE COMPOUNDS.—The S. Obermayer Co., Cincinnati, has issued a neat little booklet entitled "Money Making Hints for the Core Room." It is handsomely illustrated showing a small boy at work in the core shop, and these views are used to reflect the ease with which cores can be made with Kantbebeat compound. It also contains valuable suggestions on the production of cores.

PUMPS.—The Knowles Steam Pump Works, 115 Broadway, New York City, has published five bulletins illustrating and describing the Knowles single, horizontal, piston pumps, boiler feed and tank pumps, both single and duplex, as well as mine pumps. The Geo. F. Blake Mfg. Co. has also issued bulletins descriptive of Blake vertical high speed engines, and single and duplex feed and tank pumps.

MACHINE TOOLS.—Manning, Maxwell & Moore, Inc., 85 Liberty street, New York, have just issued a most comprehensive catalog of machine tools. The book is bound in cloth, and has 1,175 9 x 12-inch pages. It presents fully and in great detail the extensive line of tools developed for use with modern high speed steel, together with the latest devices in motor drives. The tools illustrated and described are carefully grouped, enabling one to examine with facility the complete line of a given type of tool. As an example, the first 125 pages present a carefully chosen line of tools for railroad machine shop use, including wheel lathes, car wheel borers, wheel presses, mud ring and flue sheet drills, crank pin presses, cylinder boring machines, etc. A large section of the catalog is given up to planers of all types and capacities, while boring mills, slotting machines, milling machines, lathes, screw machines, drills, and other standard machine tools of a great variety of sizes and types are listed in appropriate groups. Forging tools, such as bulldozers, hammers, flanging machines and riveters, comprise another section, among other machinery presented being blowers, portable tools, shears, presses, punches, cranes, grinders, vises, woodworking tools, etc. The book, handsomely printed on heavy coated paper, is profusely illustrated, and contains over 2,500 cuts. The mechanical work is of the highest type, and fully in keeping with the character of the material described.

GENERAL INDUSTRIAL NOTES

The new foundry department of the Bollinger-Andrews Construction Co., Verona, Pa., was recently placed in operation. The foundry building is of steel construction 60 x 360 feet with a 30-foot lean-to on one side and a 40-foot lean-to on the other. The foundry is equipped with three Morgan electric traveling cranes and the melting equipment consists of two 96-inch Whiting cupolas. A new pattern shop was also recently erected, 40 x 80 feet.

The Powers & Maxwell Foundry Co., Darlington, Beaver Co., Pa., is winding up its affairs and the charter will be surrendered. This action is voluntary and all liabilities will be taken care of by the company.

The Beard Foundry, Fayetteville, N. Y., has been purchased by Wm. N. Crouch, Norwood, N. Y. He intends making extensive improvements to the plant and will carry on a general jobbing foundry and machine shop business.

The Eureka Casting & Machine Co., Dayton, Ohio, recently incorporated with $25,000 capital, will take over the Eureka Foundry Co. The incorporators are: John Zimmerman, Charles B. Drury, Aldred A. Thomas, Jesse B. Gilbert and A. J. Althoff.

The Standard Pattern Works, 5333 St. Clair avenue, Cleveland, which has been operated as a partnership, has been incorporated under the name of Standard Pattern Works Co., with a capitalization of $10,000.

The plant of the Independent Stove Co. has been removed from Detroit to Owosso, Mich. The new foundry is 74 x 190 feet and a two-story manufacturing and storage building has also been built, 64 x 175 feet. The Detroit plant has been leased to the Brush Runabout Co. The Independent Stove Co. has established an office, sample floor and warehouse in Detroit at 96 Jefferson avenue.

The Standard Crucible Steel Castings Co., Philadelphia, has been incorporated with a capital of $75,000 by A. Penrose, Frederick Gunies and Nicholas Sheeran.

The new foundry of the Southern Wisconsin Foundry Co., Madison, Wis., is rapidly nearing completion. The building is of cement block construction, 50 x 145 feet.

The Chelsea Stove & Mfg. Co., Chelsea, Mich., has been organized with a capital stock of $400,000 and has purchased the plant of the Glazier Stove Co. at receiver's sale. Officers have been elected as follows: Alexander McPherson, president; Emory W. Clark, vice president; Ralph L. Stone, secretary and treasurer. H. L. Stanton, manager of the Glazier plant during the receivership, will continue in that capacity.

The Gibbs Foundry & Furnace Co., Watsontown, Pa., recently took over the Susquehanna Foundry & Machine Co.'s plant, and is preparing to make extensive repairs and alterations.

The Calhoun Foundry Co., Alliston, Ala., has been incorporated to take over and operate the plants of the Alabama Pipe and Casting Co., and the Birmingham Concentrating & Iron Co. The officers of the new concern are: R. H. Elliott, Birmingham, Ala., president; John M. Stillwell, Anniston, secretary and treasurer, and J. J. Farmer, Birmingham, manager.

The new plant of the Keystone Steel Casting Co., Avonmore, Pa., which has been under construction for about a year is practically completed. The company owns a tract of about six acres adjoining the plant of the West Penn Foundry Co. The main building is 110 x 210 feet and is equipped with a seven-ton cupola, a three-ton Bessemer converter, and a five-ton open-hearth furnace. The pattern shop is located in a storage building 50 x 65 feet. John Sauers is president of the company and Alfred Tompkins is secretary.

The Bluffton Foundry & Machine Co., Bluffton, O., has been incorporated by E. T. Paul and others with a capital of $5,000.

The Nortmann-Duffke Foundry Co., Milwaukee, Wis., has just completed a one-story fireproof pattern storage vault, 30 x 50 feet, with roof and sides of reinforced concrete.

The Atlas Foundry Co., Marion, Ind., has acquired the plant at that place formerly occupied by the Ward Fence Co., and has installed a cupola and other foundry equipment.

The Rickersberg Brass Co. has completed its new plant at Perkins avenue and East Thirty-seventh street, Cleveland. The main building is 70 x 250 feet, one story, and the foundry 50 x 60 feet. An addition to the foundry 50 x 70 feet is already under way. This concern will manufacture a staple line of plumbers' brass goods.

The International Radiator Co., Philadelphia, has been incorporated with a capital stock of $100,000. The incorporators are E. T. Prince, Frank W. Dilks and Robert J. Savedge.

The Vincennes Foundry & Machine Co., Vincennes, Ind., has been incorporated with $20,000 capital. Edwin E. Shepard is president, and Hugh P. Harbin, secretary and treasurer.

The Middletown Foundry Co., Middletown, Daughin county, Pa., has been incorporated with $6,000 capital by H. S. Roth, New York; McNeal and A. K. Wallace, Middletown.

The new plant of the National Sanitary & Mfg. Co., Salem, O., is rapidly nearing completion. It includes a foundry and enameling plant 140 x 200 feet. The daily output will include 75 bath tubs, and about 250 other pieces, including foot baths, sinks, lavatories, etc.

The foundry department of the Franklin Moore Co., Winsted, Conn., has been sold to the Sessions Foundry Co., Bristol, Conn. The foundry department was only a small part of the business of the Franklin Moore Co., and it was sold to permit this concern to give more attention to its bolt and crane departments which it is enlarging.

The H. W. Cooper Saddlery Hardware Mfg. Co., Moline, Ill., recently took off its first heat in its new malleable foundry.

The Standard Gage Mfg. Co., manufacturer of indicating and recording gages, removed its plant from Syracuse, N. Y., to Foxboro, Mass., about Nov. 1. This plant, recently purchased, comprises a site of about 10 acres with the buildings already erected. The two main structures are 60 x 210 feet each, and the remainder of the plant includes a foundry 60 x 150 feet, two-story pattern shop 30 x 42 feet, and a blacksmith shop 38 x 42 feet.

The Gibbs Foundry & Machine Co., Watsontown, Pa., has acquired the Susquehanna Foundry & Machine Works and is making repairs preparatory to placing it in operation for the manufacture of furnaces and attachments that can be applied to hot air furnaces.

The New Orleans Foundry Co., which recently purchased the plant of the Schwartz Foundry Co., New Orleans, has been incorporated with $200,000 capital. Officers have been elected as follows: Louis Kohlmann, president; A. Katz, vice president, and Sigmund Kohlmann, secretary and treasurer.

The Canadian Iron Corporation, Ltd., recently organized, is a consolidation of existing blast furnaces at Londonderry, Nova Scotia; Midland, Ont.; Drummondsville and Radner, Quebec; and cast iron pipe foundries at Londonderry, Nova Scotia; Three Rivers and Montreal, Quebec; and St. Thomas, Hamilton, Midland and Fort William, Ont. This consolidation practically controls the Canadian cast iron pipe production, and there is no danger of foreign competition, inasmuch as a tariff of $8 a ton is levied against American producers, and the preferential tariff, which is chiefly aimed at the pipe foundries of Scotland, is $6 a ton.

Work has been commenced on the new foundry of the Auburn Foundry Co., at Albany, Ind. The principal product will consist of automobile castings.

The Jackson Brass Foundry, Jackson, Mich., recently organized by R. P. Bauer and J. Van Walkenburg, has equipped a plant at 111 East Cortland street, for the manufacture of high grade brass and aluminum castings.

The Clifton Forge Machine & Foundry Co., Clifton Forge, Va., has been incorporated with $25,000 capital to engage in the manufacture of iron and brass castings. C. H. Smith is president, L. B. Smith vice president, and B. C. Goodwin secretary and treasurer.

New Construction.

The Cleveland plant of the National Malleable Castings Co. will be enlarged by the erection of a new building to be used as an annealing house. It will be one story high, 132 x 556 feet.

The Electrical Alloy Co., Morristown, N. J., has been incorporated with a capital of $50,000, and will engage in the manufacture of alloys used in electrical apparatus. The incorporators include Frank S. Reigert, New York; Wilmot H. Kissam, West Orange, N. J., and Joseph E. Packer, Undercliff, N. J.

The American Steel Foundries will erect a pattern shop at Granite City, Ill., two stories high and 40 x 150 feet in dimensions. It will be of fireproof construction throughout, and the estimated cost is $25,000.

Plans have been completed by the Great Western Stove Co. for the erection of a foundry at Leavenworth, Kas., to be located at the southwest corner of Main and Choctaw streets.

The Standard Bronze & Brass Co. has established a foundry at 184 West Broad street, Columbus, O., and will engage in the manufacture of brass, bronze, copper and aluminum castings.

The LaMay Machine Works, Rochester, N. Y., has purchased a site of 15 acres, on which it will erect an extensive plant for the manufacture of special machinery. The first group of buildings will include an erecting shop, power house and a brass foundry, 30 x 50 feet.

The Republic Stove & Mfg. Co., Cleveland, will erect an addition to its plant on East Fortieth street. The new building will be 60 x 74 feet, of brick construction, two stories high. The new equipment will be purchased about the first of the year.

The Standard Sanitary Mfg. Co., Pittsburg, has completed plans for the erection of a new foundry at New Brighton, Pa. The building will be 140 x 180 feet and will be constructed of steel and concrete. The new foundry will be equipped with several cupolas, molding machines and other appliances. The company has also arranged for the erecting of a new enameling building in connection with its Louisville plant, which will be 75 x 210 feet.

The Marshall Car Wheel & Foundry Co., Marshall, Texas, will erect an addition to its plant, 30 x 70 feet.

The Frazier Stove Co., Indianapolis, Ind., will erect a new foundry at Anderson, Ind., at an estimated cost of $25,000.

Sayre Bros., Phoebus, Va., whose plant was burned several months ago, will rebuild the same of concrete. The foundry will be 45 x 190 feet, with a lean-to on one side 19 x 24 feet. The machine and pattern shops will be housed in separate structures.

The Badger Malleable & Mfg. Co. has broken ground at South Milwaukee, Wis., for its new plant. The main foundry will be of concrete, brick and steel construction, 444 feet long, of which 260 feet will be 80 feet wide, 104 feet will be 100 feet wide, and 80 feet, 90 feet wide. The machine and pattern shops will be 60 x 200 feet. Other buildings will include supply sheds, 120 x 24 feet, pattern vault, 20 x 50 feet, and warehouse 200 x 60 feet.

The American District Steam Co. has commenced rebuilding its plant at Tonawanda, N. Y., which was destroyed by fire about a month ago. The buildings will be of reinforced concrete construction, and will include a foundry 100 x 143 feet, machine shop and several other structures.

The Gawley Foundry & Machine Co., Tacoma, Wash., began the erection of a machine shop and foundry on the east side of the city waterway. The building will be 50 x 322 feet.

The Union Malleable Iron Co., Moline, Ill., is adding another air furnace and when completed the melting equipment will be increased to seven furnaces.

The Tropenas Steel Co., New Castle, Del., has awarded the contract for an additional building 90 x 180 feet, which is the same size as the building recently completed. Specifications for the machinery required for the new structure have not yet been completed.

The Rock Island Tool Co., Rock Island, Ill., will erect a one-story foundry and machine shop 80 x 160 feet. E. C. Bettendorf is secretary and general manager of the company.

The Mesta Machine Co., Pittsburg, is building a new foundry 300 feet long and has recently purchased considerable equipment for this addition.

The Manitowoc Aluminum Foundry Co., Manitowoc, Wis., is erecting an addition to its plant 100 x 200 feet, two stories high, of fireproof construction, which will be used as a core and machine shop. This concern also recently purchased a lot 80 x 165 feet south of its plant upon which another building will be erected early next year.

The Amherst Malleable Iron Co., a Pennsylvania concern, conferred with members of the Everett, Wash., chamber of commerce with a view of securing a site for the erection of a malleable foundry at that place. The proposed plant is to employ 100 men.

The Quinn Wire & Iron Works, Scranton, Ia., will remove its plant to Boone, Ia. The new foundry will be 48 x 90 feet and the machine shop 132 x 144 feet.

The Advance Stove Works, Evansville, Ind., will erect an addition to its foundry at Read and Indiana streets.

The Pitts-Thompson Foundry Co., Dubuque, Iowa, is having plans prepared for the erection of a new plant which will have a much larger capacity than the present foundry.

Large additions are being made to the Sharon, Pa., plant of the National Malleable Castings Co. These improvements include two buildings, one 72 x 250 feet, and the other 40 x 425 feet.

The American Car & Foundry Co. will erect a foundry at St. Louis at an approximate cost of $90,000. The main building will be 134 x 364 feet and the core shop will be 36 x 95 feet.

The Rockmart Stove & Foundry Co., Rockmart, Ga., has completed plans for the erection of a stove plant at Ft. Worth, Texas. L. Kimball is general manager of the company.

The plant of the Peoria Foundry Co., Peoria, Ill., recently destroyed by fire will be rebuilt. The new foundry will be 100 x 212 feet.

At a meeting of the Columbus Mach. & Foundry Co., Columbus, Miss., it was decided to rebuild the plant which was badly damaged by fire early in October.

The Kutztown Foundry & Machine Co., Philadelphia, will make a number of extensions and improvements to its plant at Kutztown, Pa. The nature of these extensions has not been definitely decided upon.

The Falk Co., Milwaukee, manufacturer of steel castings, will erect another large addition to its foundry.

The Central Iron & Coal Co., 37 Wall street, New York City, has under construction a large cast iron pipe foundry at Holt, Tuscaloosa Co., Ala., where this concern now operates a blast furnace.

A new foundry will be built at Wellington, Kas., by M. K. Weigel, of the E. Killing's Molding Machine Works, Davenport, Iowa. Mr. Weigel requests that catalogs and prices for foundry equipment be sent in his care at Wellington, after Jan. 1.

The York Mfg. Co., York, Pa., has begun the construction of a large malleable iron foundry.

The Royal Brass Mfg. Co., Cleveland, manufacturer of plumbers' brass goods, has increased its capital from $10,000 to $25,000 to provide funds for the erection of a new plant, including a brass foundry. Equipment for this extension will shortly be purchased.

The Allyne Brass Foundry Co. will erect a one story addition to its Detroit plant, 40 x 60 feet in dimensions.